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of the

American Ceramic Society

Abstracts Bulletin

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Related to the Silicate Industries

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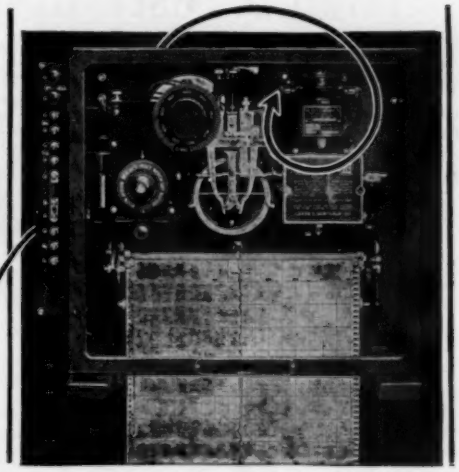

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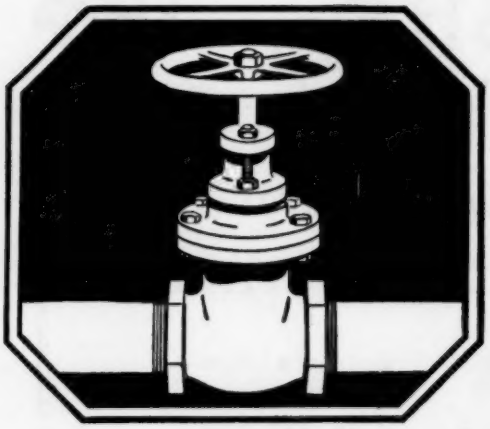

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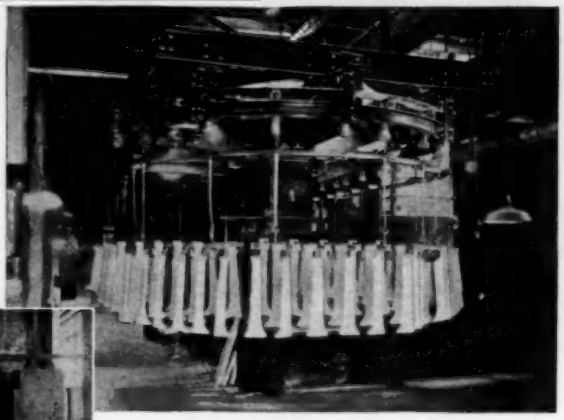

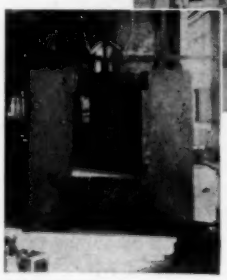

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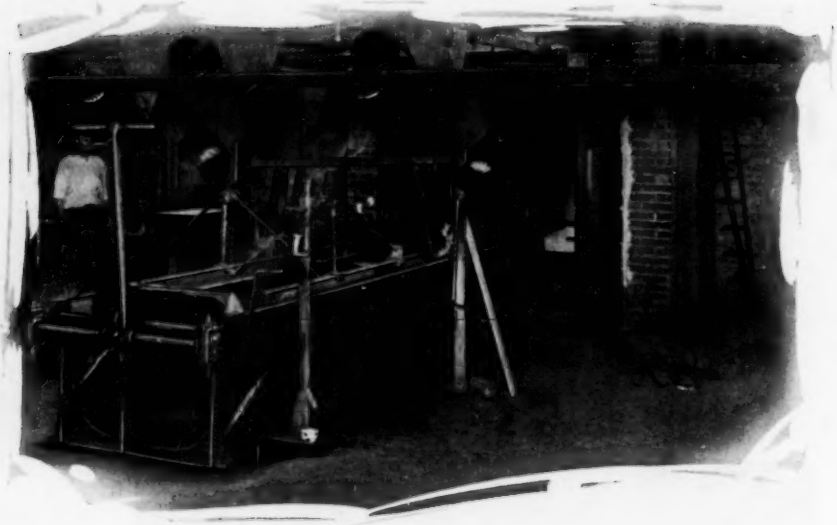

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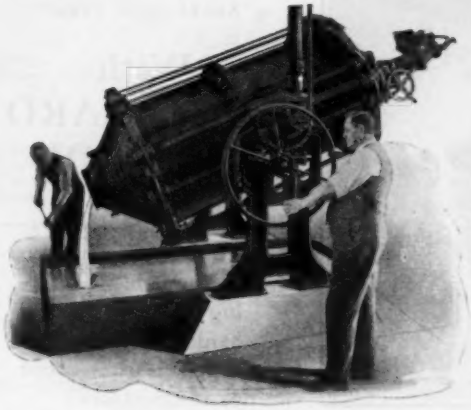

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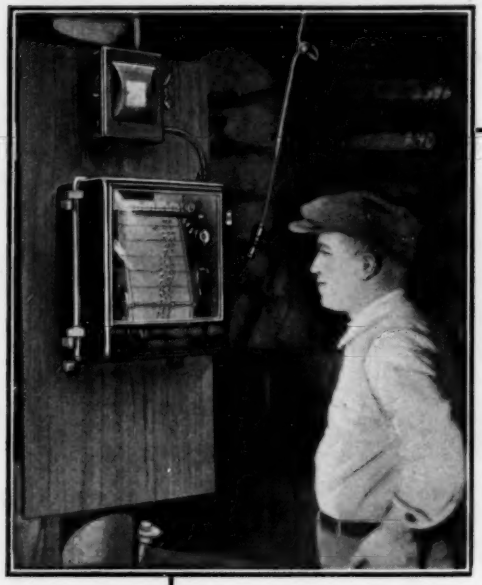

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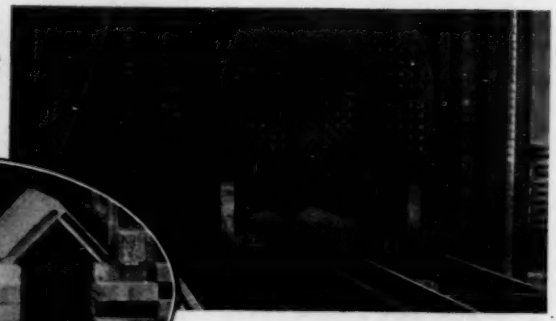

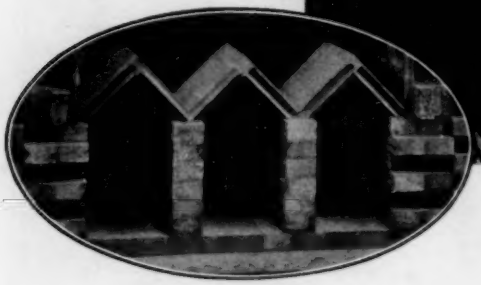

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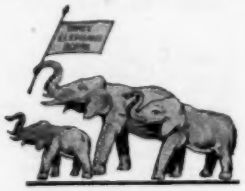

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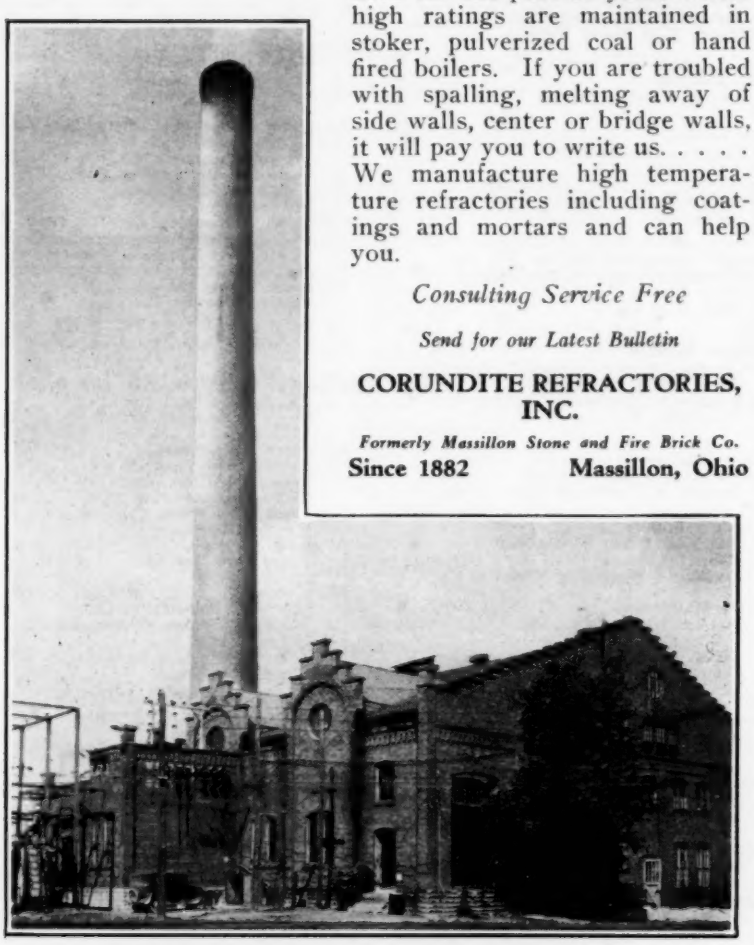

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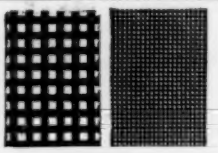
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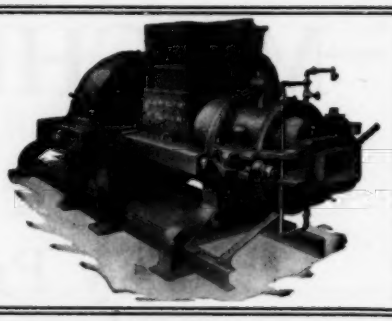

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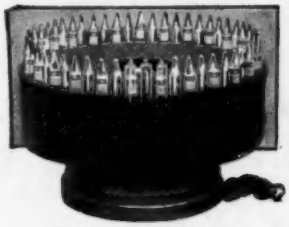

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EFFECT OF HEAT TREATMENT ON DIATOMACEOUS EARTH[1]

By Hobart M. Kraner

ABSTRACT

This paper deals with the heat treatment of diatomaceous earths collected from a few commercial deposits throughout the country. It was originally intended to study the effect of heat treatment upon the various types of diatoms which occur in these deposits and the study was not intended to have any particular practical application. The results of the study indicate that the change of structure incident upon higher heat treatment is more dependent upon the chemical composition (impurities) than it is upon the diatom structure. An air-floated sample which was quite pure showed little deterioration up to 1300°C.

The refractoriness of a diatomaceous earth as indicated by the cone fusion test is often used as a criterion of insulating range of a diatomaceous earth. This is undoubtedly a good indication, but it does not take into consideration the changes in structure of the material before deformation.

Whether the insulating value of a diatomaceous earth is dependent upon the fluffiness of the material, upon the air cells of the diatom structure, or both, may also be of considerable importance. For this reason it seemed that a microscopic examination of various types of diatomaceous earths after heating at critical temperatures would prove interesting at least.

Each of several sets of samples was fired to the respective indicated temperatures at the rate of 200°C per hour and held at that temperature for two hours. This insured similar heating rates for each group.

Cones of the samples were made by molding with organic binder. These were placed in a plaque and fired to 1300°C at 50°C per hour and in this firing cone 14 was put half down. In this firing it was expected that there would be some deformation; only cone 6 had deformed and cone 2 just started.

It is apparent from the photomicrographs, that diatomaceous earth No. 1 retains its structure through heating to 1260°C, but that a very noticeable deterioration takes place at 1300° as evidenced by the glassy edges appearing on the diatom together with a diminution of the cellular structure. This sample retains its structure longer than any of the other samples.

Earth No. 2 shows distinct sintering at 1100°C and total disappearance of structure at 1260°C.

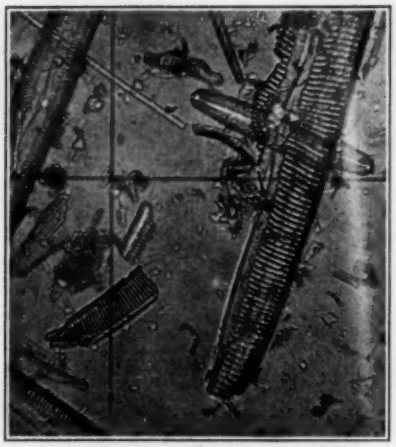
Number 3 shows some sintering at 1100 and 1260° with no structure remaining at 1300°C.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.) Received March 10, 1928.

TABLE I

Specimen	Source	SiO_2 (%)		Condition				
		Sample as recd.	After ignition	As recd.	1100°C 2 hrs.	1260°C 2 hrs.	1300°C 2 hrs.	Cone 14
1	Air floated, Wilmurt, N. Y.	91.8	96.1	White	White (unsintered) Diatom structure O. K.	White (unsintered) Structure affected	White (unsintered) Structure disappearing	Upright White
2	Tucson, Ariz.	78.4	83.7	White slightly creamy	Pink (unsintered) Diatom structure O. K.	Creamy (sintered) Structure destroyed	White glass Structure destroyed	Deformation Gray glassy
3	Maryland	91.5	97.0	Buff	Tan (unsintered) Diatom structure O. K.	Brown (sintering) Structure affected	Brown (sintered) Structure destroyed	Upright Brown Cinder
4	Car, Nev.	73.1	80.1	Creamy	Dark salmon (unsintered) Diatom structure O. K.	Tan (sintering) Structure affected	Dark tan (sintering) Structure destroyed	Upright Iron-stained
6	Los Angeles, Calif.	58.5	68.3	Creamy	Creamy (sintered) Diatom structure destroyed	Melted	Melted	Deformed at cone 8
8	Calvert, Md.	70.1	76.0	Tan	Tan (unsintered) Diatom structure disappearing	Brown (sintered) badly) Structure indistinct	Dark brown (sintered badly) Structure destroyed	Upright Light brown
10	Lompoc, Calif.	87.5	92.6	Creamy	Creamy (firm) Structure affected slightly	White (firm) Structure partially destroyed	Creamy (slight sinter) Structure	Upright White



(*a*) As received (400×).

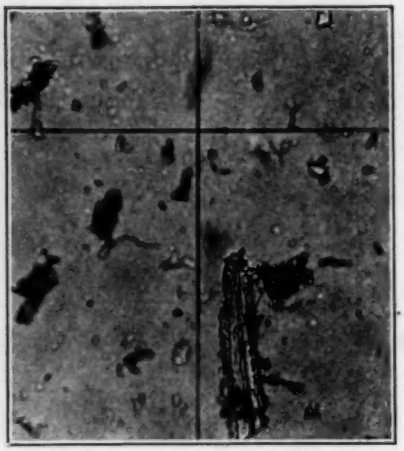
(*b*) 1100°C (400×).

(*c*) 1260°C (400×).

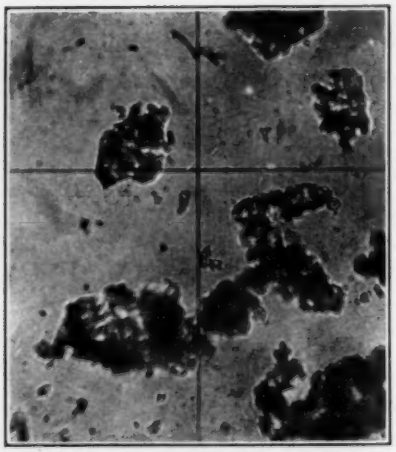
(*d*) 1300°C (400×).

FIG. 1.—Diatomaceous earth, No. 1.

(*a*) As received (400×).



(*b*) 1100°C (400×).



(*c*) 1260°C (400×).

FIG. 2.—Diatomaceous earth. No. 2.

(*a*) As received (400×).

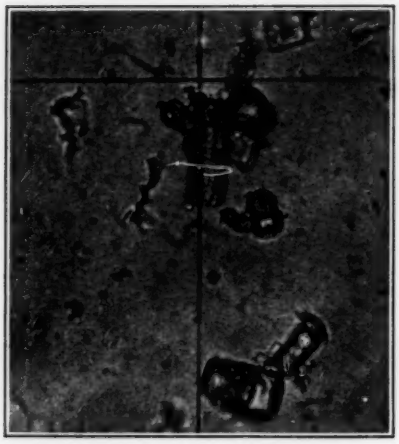
(*b*) 1100°C (400×).

(*c*) 1260°C (400×).

FIG. 3.—Diatomaceous earth, No. 3.

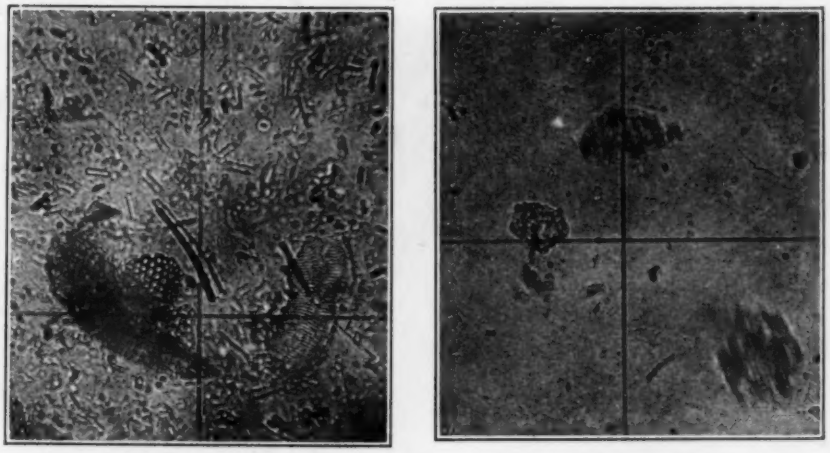
(*a*) As received (400×).

(*b*) 1100°C (400×).



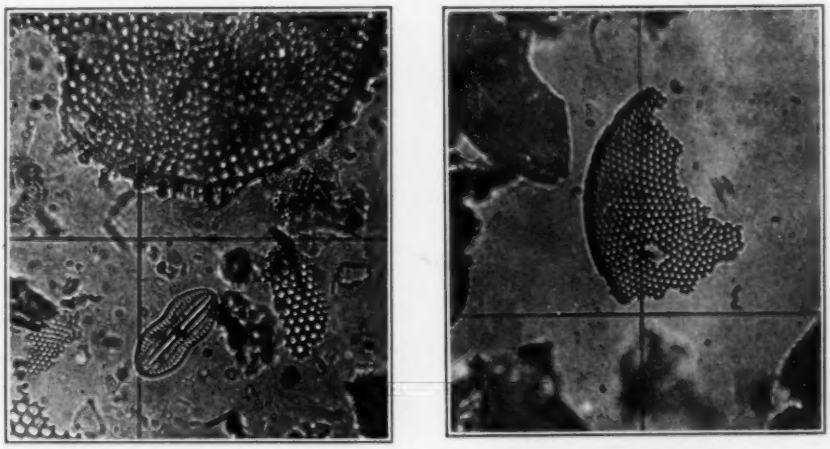
(*c*) 1260°C (400×).

FIG. 4.—Diatomaceous earth, No. 4.



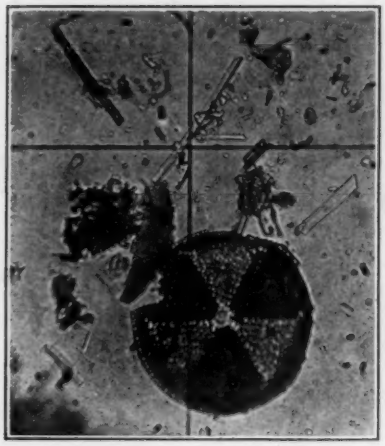
(*a*) As received (400×). (*b*) 1100°C (400×).

FIG. 5.—Diatomaceous earth, No. 6.

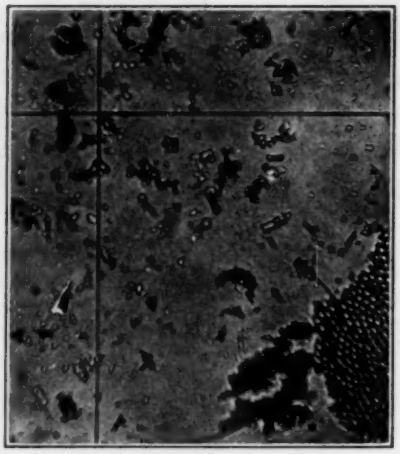


(*a*) As received (400×). (*b*) 1100°C (400×).

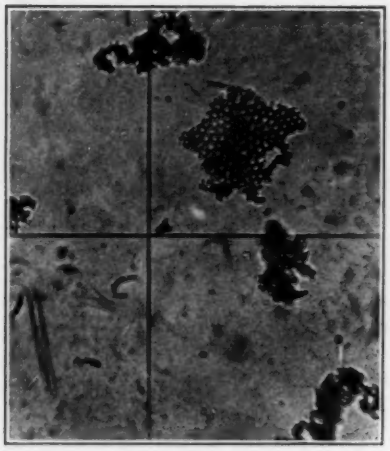
FIG. 6.—Diatomaceous earth, No. 8.



(*a*) As received (400×).



(*b*) 1100°C (400×).



(*c*) 1260°C (400×).

FIG. 7.—Diatomaceous earth, No. 10.

Number 4 shows sintering at 1100°C, a distinct action on the diatom structure at 1260, and total disappearance of structure at 1300°C.

Number 6 retains no structure even to 1100°C.

Number 8 sinters badly at 1100° and has no structure at 1260°C.

Number 10 retains its diatom structure through 1260°C, but loses it at 1300°C.

Conclusions

(1) It is apparent that the diatom structure of a diatomaceous earth may be destroyed without any indication of deformation of the material.

(2) It would seem that there is a direct relation between chemical purity and retention of diatom structure as would probably be expected, for the structures of the purest samples are not easily affected by sintering. As a result, chemical analysis or the silica content of the ignited sample can be used as a simple means of quality indication in this material. Diatomaceous earths contain water, organic matter, and carbonate impurities which necessitate using ignited sample analyses in judgment of their value.

(3) It is likely therefore that insulating limits of diatomaceous earths can be judged fairly well by cone fusion tests but that microscopic examination to determine lowest sintering temperatures is also valuable.

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THE EFFECT OF THERMAL SHOCK ON THE TRANSVERSE STRENGTH OF FIRECLAY BRICK[1]

By C. W. Parmelee and A. E. R. Westman

ABSTRACT

An apparatus is described by means of which a fire brick, initially at a temperature of 1100°C, could be subjected to definitely localized thermal stresses by cooling the center of one face of the brick with an air blast, the remaining surface of the brick being protected by means of heat insulation. By means of this apparatus, the effect of thermal shock on the transverse strength of twenty brands of fireclay brick was determined. The values obtained are compared with the other physical and chemical properties of the brands. The advantages and disadvantages involved in the use of this method as a laboratory test for the determination of resistance to thermal shock are discussed.

I. Introduction

No quantitative data on the effect of thermal shock on the transverse strength of fireclay brick have been reported in the literature. Such data are of interest in connection with the use of fireclay brick as structural units in furnaces where the temperature fluctuates and also in the development of laboratory tests for determining resistance to thermal shock. The use of strength tests for determining the extent to which ceramic products are affected by thermal shock has been suggested by Shearer,[2] McDowell,[3] and others, and data concerning the effect of temperature fluctuations on the compressive strength of fireclay brick have been published by Goodrich.[4]

In connection with an investigation of checker brick for carbureters[5] some experiments were made in which different brands of fireclay brick, whose physical and chemical properties had been determined, were subjected to repeated thermal shock under conditions comparable to those existing in carbureters. The transverse strength of the brick, so treated, was compared with the strength of untreated brick of the same brands. It is the purpose of this paper to describe these experiments, to give the data which was obtained from them, to compare the resistance to thermal shock of the different brands with their other properties, and to use the data in a discussion of the probable advantages

[1] This paper covers results obtained in connection with an investigation carried on in the Engineering Experiment Station of the University of Illinois, the detailed results of which are published in *Bull.*, No. 179, "An Investigation of Checkerbrick for Carbureters of Water-Gas Machines," by C. W. Parmelee, A. E. R. Westman, and W. H. Pfeiffer which is in press. This article is published with the permission of the Director of the Engineering Experiment Station. Received June 8, 1928.

[2] W. L. Shearer, "Zircon as a Constituent of Ceramic Bodies," *Ceramist*, 5 [6], 316 (1925).

[3] J. S. McDowell, "A Study of Silica Refractories," *Trans. Amer. Inst. Min. Eng.*, 57, 3 (1918).

[4] Hobert R. Goodrich, "Spalling and Loss in Compressive Strength of Fire Brick." *Jour. Amer. Ceram. Soc.*, 10 [10], 774 (1927).

[5] *Jour. Amer. Ceram. Soc.*, 9 [5], 290–97 (1926).

and disadvantages of a laboratory thermal shock test in which strength tests would be used in measuring the effects of thermal shock.

II. Method of Measurement

(1) Principle The method used in determining the effect of repeated thermal shock on the transverse strength of a brand of fireclay brick depended primarily upon the comparison of the average transverse strength of a sample consisting of a number of specimens chosen at random from a large shipment of brick of this brand and the average transverse strength of another sample chosen in a similar fashion which were subjected to repeated thermal shocks before the strength tests were made. The specimens, in all cases, were standard straight fire brick. In subjecting a brick to a thermal shock every effort was made to heat the brick to a uniformly high temperature and then to cool the central four inches of one 9- by $2^1/_2$-inch face by a blast of air at room temperature, the remaining surface of the brick being protected from cooling by means of insulating materials. In this way a state of tension was produced in the center of one side of the brick and any cracks which were formed would be such that they would tend to divide the brick into two equal parts. In determining the transverse strengths of the different specimens, the A.S.T.M. Method for Building Brick C21–20 was followed with the exception that the brick were broken on edge instead of flat as checker brick are ordinarily placed on edge in a carbureter. In determining the strength of the brick which had been subjected to thermal shock, the brick were placed in the testing machine so that any cracks formed at the cooled surface would have the maximum effect.

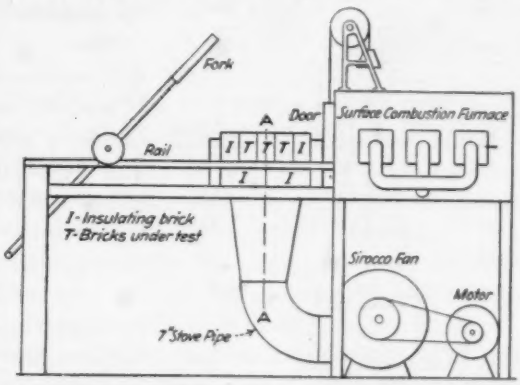

FIG. 1.—Diagram of apparatus.

(2) Apparatus A diagram of the apparatus which was used in subjecting the brick to repeated thermal shock is shown in Fig. 1. It consisted of a furnace, a traveling fork, a cooling platform, and a fan. The furnace, which was of the surface combustion type, was similar to a heat-treating furnace and was provided with a counterpoised door, which was opened only when the fork was being used.

The furnace was used to heat the test brick to a uniform temperature of 1100°C after each treatment on the cooling platform. When they were in the furnace, the test brick rested on two fireclay brick lying on the floor of the furnace and the temperature directly below their lower faces was measured by a noble metal thermocouple.

The traveling fork consisted of an iron fork which was carried by two flanged pulleys that fitted on rails made of angle iron. The fork was used in transferring the test brick three at a time from the cooling platform to the furnace and from the furnace to the cooling platform. The cooling platform, shown in section in Fig. 2, consisted of a short chimney, built of fireclay and insulating brick, which had two vertical passages, rectangular in section.

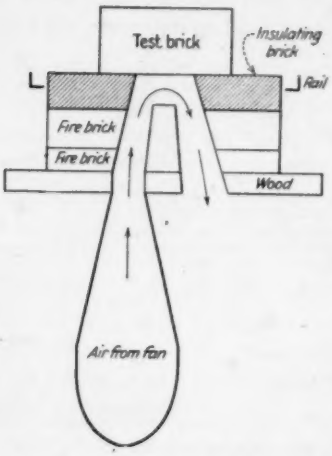

FIG. 2.—Schematic diagram of Section AA, Fig. 1.

The partition between these passages did not reach to the top of the chimney. When the test brick were placed on top of the platform by means of the fork and insulating brick were placed on either side, the top of the chimney was completely closed. The air from the fan then passed up one of the passages, under the test brick and escaped to the open air through the other passage. In this way, an area four inches by two and one-half inches on the lower surface of each test brick came in contact with the stream of air, the rest of the brick being protected by insulating brick.

The fan was a number $1^1/_2$ Sirocco fan and was driven at a speed of 1940 r.p.m. by means of a one horse-power induction motor. It was connected to one of the passages of the cooling platform by means of a 90° stovepipe elbow and an adapter which was 12 inches in length and had a circular opening 7 inches in diameter at the lower end and a rectangular opening 11 by 2 inches at the upper end.

(3) Operation About twelve bricks of the brand to be tested were heated at approximately 75°C per hour (generally overnight) in a gas-fired muffle furnace to a temperature of approximately 1000°C. The surface combustion furnace shown in Fig. 1 was heated at the same time to a temperature of approximately 1100°C.

When the desired temperatures had been obtained, three of the bricks were removed from the muffle furnace, placed quickly side by side on the cooling platform (the fan being shut off), and then put into the surface combustion furnace by means of the fork.

When the pyrometer indicated that they had reached a temperature of 1100°C, they were transferred to the cooling platform by means of of the fork; insulating brick were placed on either side, as shown in Fig. 1; soft asbestos sheets were placed between the brick, which were pushed together so that air would not escape readily; and the fan was operated for a period of exactly four minutes. At the end of this period, the brick were returned to the surface combustion furnace and left there for six minutes, the burners being adjusted so that at the end of this time, the pyrometer indicated a temperature of 1100°C.

These four- and six-minute periods were repeated until ten complete cycles had been carried out. The bricks were then returned to the muffle furnace and three other specimens were removed and treated in the same way. This was continued until all the bricks had been treated and returned to the muffle furnace, in which they were allowed to cool over night.

(4) Calculation In determining the average strength of a brand of bricks in either the untreated or treated states, the strengths of samples of twelve or fifteen bricks were first determined. If the average of these strengths had a probable error, as calculated by the Small Sample Theory of Student,[6] which was greater than 4% of its value, the strengths of more bricks of the same kind were determined and the calculations repeated. This process was continued until the probable errors of the average values in practically all cases fell within the 4% limit. With some brands, samples consisting of twelve bricks were sufficiently large to give this accuracy; with others, samples of twenty or more bricks had to be used. Using the average values, so obtained, the percentage decrease in strength for each brand was calculated, as well as its probable error.

III. Data Obtained

(5) Brands Investigated Twenty brands of fire brick were included in the tests. Data concerning their raw materials and methods of manufacture were submitted by the manufacturers and are given in Table I. It will be observed that a number of types of fire brick were included. Brands II and III were made from the same raw materials by different manufacturing processes, which is also true for Brands IX and X. Brands V, V_s, and XIX were made from the same plastic clay by the same manufacturing process; brand V_s, however, consisted of soft-fired brick and Brand XIX contained flint clay as well as plastic clay.

(6) Values Obtained The values of the percentage decrease in transverse strength of the different brands when

[6] A. E. R. Westman, "Statistical Methods in Ceramic Research," *Jour. Amer. Ceram. Soc.*, **10** [3], 133 (1927).

subjected to thermal shock are given in Table II along with their probable errors, the average strengths from which they were calculated, and information concerning the size of the samples which were used. It will be observed that the values varied from practically zero (Brand II) up to 85.7% (Brand XXV), and that the average probable errors of these values, omitting Brand V, for which adequate samples were not available, was ±3.0. In the case of any one brand, this means that, if a large number of similar samples were selected at random from the brand and subjected to the same treatment, the values obtained for

TABLE I

DATA PERTAINING TO MANUFACTURE OF FIRE BRICK (Submitted by Manufacturers)

Brand No.	Location of plant (state)	Method of manufacture*	Firing temperature (cones)	Raw materials
I	Calif.	HM	17–18	Lean, "bone" claylike bauxite
II	Mo.	DP	7†	2nd grade semiflint and plastic clays
III	Mo.	SMR	7†	2nd grade semiflint and plastic clays
IV	Pa.	DP	10–15	Pa. semiflint clay
V	Ill.	SMR	9–11	Plastic clay
VI	Pa.	HM	10–12	Flint and plastic clay
VII	Mo.	SMR	8	Plastic clay, flint clay, and grog
VIII	Mo.	SMR	10–12	Semiflint clays
IX	Ky.	HM	11	Flint and semiflint clay
X	Ky.	SMR	11	Flint and semiflint clay
XI	N. J.	HM	12	Plastic clays
XII	Mo.	DP	8–10	Plastic clay
XIII	Ky.	SDP	8	Flint, semiflint, and plastic clays
XVII	Mo.	SMR	10	High-grade plastic clay
XVIII	Ohio	AB	31	Ga. kaolin, flint, semiflint, and plastic clays
XIX	Ill.	SMR	11–12	Mo. flint and Brand V plastic clay
XXIII	Mo.	HM	14	Mo. diaspore, high-grade plastic clay
XXIV	Mo.	SMR	10	Mo. semiflint clay
XXV	Ohio	AB		Same as Brand XVIII but finer grind

* SMR: stiff-mud repress; DP: dry press; SDP: semidry press; AB: autobrick; HM: hand mold.

† Reported as 2200–2400°F.

the percentage decrease in strength would be distributed in such a manner that one-half of them could be expected to fall within ±3.0 of the true value. This error was an appreciable proportion of the range for the nineteen brands which was about 85, in spite of the fact that relatively large samples were used and that these brands differed greatly from each other in their properties.

IV. Comparison with Other Data

(7) Manufacture

Although the nineteen bands constituted a rather heterogeneous group, some relationships were found when the effect of thermal shock on the different brands was compared with their other properties. Table III affords a comparison of the method of manufacture of the different brands and their susceptibility to thermal shock. It will be seen that the stiff-mud bricks

TABLE II

EFFECT OF THERMAL SHOCK ON TRANSVERSE STRENGTH OF FIRECLAY BRICK

Brand No.	Untreated Brick			Treated Brick			Effect of Treatment	
	Average strength (lbs./sq. in.)	Size of sample (brick)	Probable error (%) ±	Average strength (lbs./sq. in.)	Size of sample (brick)	Probable error (%) ±	Decrease in average strength (%)	Probable error ±
I	710	10	2.7	415	10	0.8	41.5	1.7
II	328	14	3.4	329	18	2.9	−0.3	4.5
III	1804	15	2.0	814	13	4.0	54.9	2.0
IV	590	14	3.2	438	24	4.4	25.8	4.0
V	1254	15	2.6	699	21	3.0	44.3	2.2
VI	432	20	4.3	336	12	2.2	22.2	3.8
VII	967	15	3.0	527	15	4.6	45.5	3.0
VIII	1325	15	3.2	866	14	3.7	34.6	3.2
IX	694	18	4.0	565	15	3.3	18.6	4.2
X	1456	15	2.1	777	20	3.0	46.6	2.0
XI	843	15	4.2	577	15	3.6	31.6	3.8
XII	397	19	4.1	325	21	3.5	18.1	4.4
XIII	911	15	1.8	790	12	4.2	13.3	4.0
XVII	1243	15	3.9	819	21	5.0	34.1	4.1
XVIII	689	20	4.2	155	12	5.3	77.5	1.5
XIX	730	15	2.0	522	14	2.7	28.5	2.4
XXIII	966	15	2.5	657	12	5.2	32.0	4.0
XXIV	1208	15	2.3	772	11	3.3	36.1	2.6
XXV	2236	15	3.1	320	12	9.6	85.7	1.4
V.*	974	5	7.0	834	6	2.3	14.4	6.3

* Soft-fired brick of brand V

were more affected by thermal shock than the dry-press and hand-mold bricks. The one brand of semidry press brick was quite resistant to thermal shock. Both the brands made by the autobrik process had been fired to an exceptionally high temperature (cone 31) so that the data do not reveal much of this process.

TABLE III
METHOD OF MANUFACTURE*

	SMR	DP	HM	SDP	AB
Number of brands	8	3	4	1	2
Effect of thermal shock (av. loss in transverse strength) (%)	40.6	14.5	28.5	13.3	81.6**

* SMR: stiff-mud repress, DP: dry-press, HM: hand-mold, SDP: semidry press, AB: autobrick.
** Both brands were fired to the exceptionally high temperature of cone 31.

(8) Physical Properties A number of the physical properties of the nineteen brands of brick had been determined as part of the checkerbrick investigation. A comparison of the data, so obtained, with the thermal shock data failed to show any decided relationship in the case of permeability, thermal expansion, or expansion due to inversion at 575°C, probably due to the small number of brands and the extent to which they differed in a number of properties.

With regard to the porosities of the different brands, some relationship was evident for a number of the brands, the resistance to thermal shock increasing with the porosity. (See Fig. 3.) For other brands, however, this relationship did not hold. The points corresponding to their values are numbered in the figure.

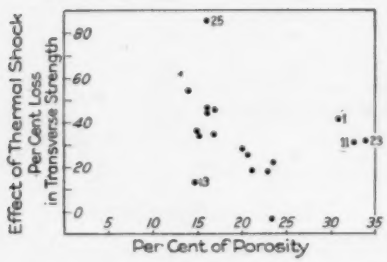

FIG. 3.—Porosity and effect of thermal shock.

A distinct relationship was found between the initial transverse strength of the brands and their loss in strength due to thermal shock. This is shown in Figs. 4 and 5. From Fig. 4, it is evident that the stronger brands lost a greater proportion of their strength when subjected to thermal shock than did the weaker brands, although their final strength was, in general, higher than that of the weaker brands. Figure 5 affords a direct comparison of the initial strength and the loss in strength due to thermal shock. The correlation coefficient[6] for these quantities was +0.83, a value which would be expected to arise from chance in less than two cases in 10,000 trials, assuming that eighteen of the brands constituted a random sample from a normal population and omitting the data for Brand XVIII, which was evidently quite exceptional. The full line in the figure is the graph of the prediction

equation calculated from the correlation coefficient, the broken lines indicate the range within which one-half the values for a large number of brands would be expected to fall, the probable error of prediction being ± 6.8.

(9) Controlled Comparisons Some of the relationships can be shown more definitely by a comparison of some of the brands which differ in only a few respects. Thus, Brands II and III, (see Table IV) afford a controlled comparison of the stiff-mud and dry-press methods of manufacture and show that bricks made by the stiff-mud process are

TABLE IV
CONTROLLED COMPARISON OF DATA

Brand	Method of manufacture	Strength decrease from thermal shock (%)	Porosity (%)	Initial strength (lbs./sq. in.)	Firing temperature (cones)	Raw materials
II	DP	−0.3	23.5	328	7	Identical
III	SMR	54.9	14.1	1804	7	
IX	HM	18.6	21.9	694	11	Identical
X	SMR	46.6	16.5	1456	11	
V	SMR	44.3	16.7	1254	9–11	Identical
V_s	SMR	14.4	—	974	<9	
XIX	SMR	28.5	20.1	730	11–12	Brand V plastic + Mo. flint clay

more susceptible to thermal shock. Similarly a comparison of the data for Brands IX and X, Table IV, shows that hand-mold bricks are less susceptible to thermal shock than stiff-mud bricks. The data for Brands V, V_s, and XIX, in Table IV, show that soft-fired bricks are less susceptible to thermal shock and that the introduction of flint clay into a stiff-mud brick made from plastic clay increases the resistance to thermal shock.

V. Use of Method as Laboratory Test

(10) Advantages It is conceivable that a procedure similar to that described in Part II of this paper might be used as a laboratory test for determining the probable service value of a brand of bricks when used in installations where rapid temperature changes would be encountered. Such a procedure has been advocated at different times. The data given in Table II can be used to advantage in discussing the advantages and disadvantages of such a test as compared with the more usual dipping tests, such as the tentative method of the American Society for Testing Materials,[7](C38–27), in which one end of each test brick is heated in the door of a furnace maintained at 1350°C and is then dipped to a depth of two inches in water. This

[7] "Tentative Method of Test for Resistance of Fireclay Brick to Thermal Spalling Action," (C38–27), Tentative Standards, A.S.T.M. (1927).

treatment is continued until the brick loses 20% by weight from spalling, the average number of treatments for five brick of each brand being reported as the spalling index.

The air-blast procedure produces a more definite and reproducible state of stress than is usual in the water-dipping tests, where the greatest stress sometimes occurs at some distance from the hot end of the brick, particularly at the water line. The uncertainty of the stresses produced is shown by the fact that 2-inch dipping did not give results intermediate between those obtained with 4- and 1-inch dippings.[8]

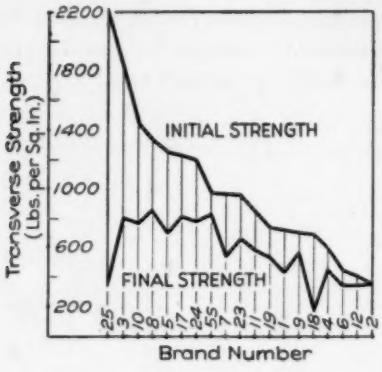

FIG. 4.—Initial strength and final strength.

The use of transverse strength tests for determining the effect of thermal shock does not require as severe treatment as when actual spalling must be brought about. Their use also makes the values obtained less dependent on the personal equation of the operator, as the strength of a brick is a more definite quantity than the amount which can be removed by "thumb pressure."

(11) Disadvantages The principal disadvantages involved in the use of the apparatus and procedure which have been described are the equipment required, the possible discrimination against brick having appreciable cohesion when cracked, and the sampling errors involved.

To use the test, machines for measuring transverse strength are required and some equipment must be built for carrying out the air blasting. This disadvantage would be offset in many cases by the fact that the tests can be made more quickly than the standard dipping tests.

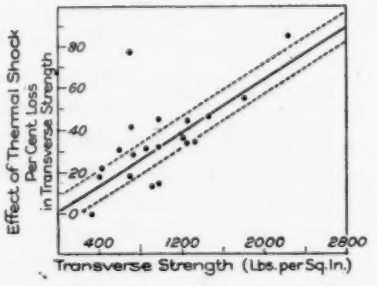

FIG. 5.—Transverse strength and effect of thermal shock.

Some brands of brick will hold together even when badly cracked, a property which is sometimes useful in service. It is possible that such brands would not show to full

[8] S. M. Phelps, "A Study of Tests for Refractories with Special Reference to Spalling Tests," Amer. Refrac. Inst., *Tech. Paper*, No. 1, 1926.

advantage in a thermal shock test based on strength measurements, as the forces involved in cohesion of this type are relatively small.

As shown in Section 8, the average probable error of the values obtained is about ±3.0. These errors are due largely to sampling and could be reduced by increasing the size of the samples. As sampling errors decrease approximately as the reciprocal of the square root of the number of brick used, very much reduction would require the use of unwieldy samples. Thus, samples of about sixty bricks would be required to reduce this error to ±1.5. The tentative standard dipping test specifies the use of samples of at least five bricks. As no data have been published from which the sampling errors of this test could be calculated, comparison is not possible at this time.

TABLE V

COMPRESSIVE STRENGTH DATA OF GOODRICH

Brand	Average strength retained (%)	Probable error (±)	Thermal spalling index	Probable error (±)
1	68.0	2.0	54.9	3.4
2	72.7	4.3	72.7	4.3
3	74.4	4.2	68.3	6.5
4	77.1	2.1	65.5	4.2
5	82.4	2.9	82.4	2.9
6	85.7	2.4	85.7	2.4
7	83.7	2.6	76.8	3.8
8	79.5	3.6	75.6	4.0
9	80.3	3.8	80.3	3.8
Range	17.7		30.8	
Average probable error	±3.1		±3.9	

(12) Comparison with Method of Goodrich

Goodrich[4] has recently published data giving the loss in compressive strength due to thermal shock of nine brands of fireclay brick and has proposed the use of such data as indices of thermal spalling tendencies. In Goodrich's experiments, each test brick was cut in two by means of a cut-off disk; one-half of the brick was subjected to thermal shock, and then its compressive strength was compared with that of the other half. The thermal shock was produced by heating the half brick at 1250° for one hour, allowing it to cool in quiet air for one hour, and then repeating this treatment until five cycles had been completed. Samples of five specimens were used for each brand. Since he has reported his data in rather complete form, it is possible to compare them with the data presented in this paper.

The average percentage of the original strength which was retained by samples of nine brands of brick which were tested by Goodrich are given in the first column of Table V*; in the second column the probable

* These values will be found to differ in one or two cases from the final values reported by Goodrich as they have been calculated as average percentages rather than percentage of averages but mainly because Goodrich's final values do not agree with his data in all cases.

errors of these values calculated from his data are given. The average proable error is about ± 3.1, which is quite large when compared to the range of his values which is only 17.7. Goodrich found that five of the nine brands suffered actual spalling loss and, to obtain his final ratings, penalized each brand according to its percentage loss in weight. By this procedure, the values shown in the fourth column of Table V are obtained. It will be observed that the penalizing has nearly doubled the range of values but has also increased the probable error of the values for the penalized brands, so that the gain is not very great.

Although Goodrich used samples of only five specimens, the probable errors of his values in column 2, Table V are about the same as the errors of our values obtained with about fifteen brick samples. This is partly due to the greater range of our values but is also due to the fact that the variation in compressive strengths in the average brand is not as great as the variation in transverse strengths and to the advantage obtained by the direct comparison of two halves of the same brick. This latter effect is due to the correlation between the strengths of halves of bricks, which is evident in Goodrich's data and which decreases the probable error of the final values when they are calculated as average percentages rather than percentages of averages.[6]

As compared with the procedure which we followed, therefore, that of Goodrich is simpler and has smaller sampling errors for the same size of sample but produces actual spalling of the brick and, as far as we can tell from data for nine brands, does not give as wide a range of values as is desirable, even when the brands which spall are penalized.

(13) Possible developments The foregoing discussion has shown some of the advantages and disadvantages of the different methods which have been proposed for the determination of thermal spalling tendency. The method involving transverse strengths is relatively short and precise and does not require severe treatment of the specimens but necessitates special equipment and has fairly large sampling errors unless large samples are used. The method involving compressive strength measurements is simpler, has relatively smaller sampling errors but is less exact and does not give a desirable range of values even when severe enough to cause actual spalling. The Tentative Standard Method of the A.S.T.M. is relatively simple but depends more upon the operator and requires severe treatment of the specimens. Its sampling errors have not been reported.

Since the sampling errors of the other tests are known, those of the tentative standard should be determined. The final criterion, of course, should be ability to predict service value and should be determined by service tests, but no test with large sampling errors can make reliable predictions.

The strength-test methods could possibly be improved by comparing the strengths of the specimens subjected to thermal shock with other specimens which have been subjected to a heat treatment which would cause the same amount of vitrification. This would allow for increases in strength which may take place during the test in the case of soft-fired brick.

Since the correlation which was found between the effect of thermal shock and the transverse strength of the twenty brands of brick was rather high when it is considered that the values used in determining the correlation were subject to appeciable errors, it is possible that further work would enable the results of thermal shock tests to be predicted from transverse strength measurements with sufficient accuracy to make the tests unnecessary.

VI. Summary

(1) Data showing the decrease in transverse strength of twenty brands of fireclay brick when subjected to thermal shock have been reported along with their probable errors, size of sample, etc.

(2) The apparatus and procedure by means of which the data were obtained have been described.

(3) A comparison of these data with other data pertaining to these brands indicated that the strength of stiff-mud fireclay brick was more affected by thermal shock than that of dry-press or handmold brick; that brick made wholly from plastic clay were more affected by thermal shock than those in which other clays were used, that more porous brick were less affected but that there were definite exceptions to this rule; and that brands having a high transverse strength suffered a proportionately greater decrease in strength when subjected to thermal shock than did weaker brands.

(4) The effect of thermal shock on the transverse strength of a brand of fireclay brick can be predicted with a probable error of about ± 6.8 from its transverse strength. It can be measured by the procedure described with a probable error of about ± 3.1.

(5) The use of the procedure described in this paper as a laboratory test for thermal spalling tendency has been discussed. A comparison has been made with the procedure proposed by Goodrich and the Tentative Method of the A.S.T.M.

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MANUFACTURE OF STONEWARE AND FLOWER POTS IN A SMALL PLANT[1]

By Frank A. Kirkpatrick

ABSTRACT

A brief description of the manufacture of household stoneware and flower pots in a 3-kiln plant in the Southwest and of improvements made in bodies, glazes, and processing.

Stoneware Bodies

The stoneware is made of a coal-measure fire clay from Calhoun, Mo. The clay is fine-grained and rather sandy, containing 40 to 50% of quartz. Other clays are mixed with it to improve strength and working qualities and to overcome the effects of variability of the amount of quartz.

Laboratory experiments were made with two plastic clays, one a shale which overlies the fire clay, the other an Illinois stoneware clay. Bodies were made by blunging, passing through a 40-mesh screen, and drying on plaster. Small test pieces were made and fired to cone 4 and cone 9 in production kilns in 60 hours. The results are given in Table I.

TABLE I

BODY PROPERTIES

Composition	*A*	*B*	*C*	*D*	Notes
Mo. fire clay	100	90	80	67	Sandy
Mo. shale		10	20		Strong plastic
Ill. stoneware clay				33	Plastic
Water of plasticity	23	26	28	24	Per cent on basis of dry clay
Drying shrinkage	6.2	6.5	6.5	6.1	Per cent on basis of wet clay
Modulus of rupture (Green)	425	502	558	463	Bars 1 x 1 x 7 in. (lbs. per sq. in.)
Fired (cone 4)					Orton cone
Modulus of rupture	3050	3170	3830	3690	Lbs. per sq. in.
Absorption	7.7	8.1	4.7	7.2	Per cent water absorption by weight
Total shrinkage	8.4	8.3	10.0	8.9	Per cent on basis of wet clay
Fired (cone 9)					
Modulus of rupture	3100	3560	4340	3790	Bars $^{1}/_{8}$ x $^{1}/_{8}$ x 5 in.
Absorption	5.0	3.4	2.0	4.1	Temp. 70°F.
Total shrinkage	9.1	10.1	10.9	9.2	Per cent on basis of wet clay

A is the fireclay body and the weakest of the four. *C*, with 20% shale, is strongest. Its shrinkage and absorption are within satisfactory limits. Bodies *A* and *D* do not change much in strength in the

[1] Received April 3, 1928.

heat interval, cone 4 to cone 9, while *B* and *C* increase in strength by vitrification of the shale. None of the bodies is overfired. The color of the fired shale is red, but 20% in body *C* causes only slight increase of yellow in the buff body.

Glazes

Several changes were made in composition of glazes. Waste plaster was replaced by borax as the adhesive. Fusibility of the Bristol glaze was increased by addition of whiting and zinc. The brown glaze was enriched in color by addition of 7% of fluxes and colors. The glazes mature at cones 5 to 7 in the periodic kiln. The formulas are as follows:

Bristol Glaze		Brown Glaze	
Tenn. feldspar	65	Mich. slip clay	47
Zinc oxide	10	Albany slip clay	46
Whiting	8	Manganese dioxide	2
Flint	6	Iron oxide	1
Body clay	7	Red lead	1
Ky. ball clay	3	Feldspar	2
Borax	1	Borax	1

For the underglaze blue bands and legends there was formerly used an uncalcined mixture of cobalt oxide, clay, and flint. The color was weak and nonuniform. The following calcine was prepared and fired to cone 7.

Cobalt oxide	30
Zinc oxide	50
Flint	20

To prevent flow, the calcine is mixed with one-third its weight of ball clay. The mixture is applied by use of glycerine. The color is a deep blue which greatly improves the appearance of the ware.

Flower Pot Clays

Flower pots were formerly made of a mixture of three coal-measure surface clays found on the company property and used without washing. The pots were light salmon in color and often full of iron specks or covered with scum. The following mixture is now used:

Sandy paving brick shale	60%
Company red surface clay	40%
Barium carbonate	1

The clays are blunged and filter-pressed and produce a good red pot having no specks or scum. It is more porous than the former product, and matures at a like temperature, 1750°F.

Clay Preparation

The clays are blunged, passed through a 40-mesh screen, filtered in a screw press, and run through a horizontal pugmill. There being only one set of equipment, it is necessary to alternate washing stoneware

clay and flower pot clay and to store reserve supplies of filter cake of each kind.

There had been no agitator in the clay cistern and one was installed. Filter cloths made by a local company wore out rapidly and were replaced by cloths of good quality obtained from an Ohio manufacturer. Pugmill knives were badly worn and were replaced so that sufficient clay could be pugged for production.

Jiggering

In this plant, jiggering had become almost impossible on account of faulty equipment. Vibration was the principal trouble. Molds vibrated in the rings, rings in the heads, heads and shafts in bearings. An 80-pound jigger head was found supported by a shaft $1^1/_4$ inches in diameter. The head vibrated so that no ware, large or small, could be made accurate in dimensions. After much servicing, it was found necessary to install a shaft 2 inches in diameter. The wheel could then be used for jiggering large ware such as tall vases.

The condition of the equipment had caused the workmen to become disheartened and careless. With improvement in equipment the jiggermen became more cheerful and efficient, and produced ware of better quality. Some time was required to adjust working conditions. The 8-hour day was introduced for all employees except jiggermen, who are paid on a piece-work basis. Each jiggerman has one helper, paid by the company. The helper carries molds and helps finish the ware.

Each jiggerman makes from 5 to 10 different kinds of ware. Each kind requires a different set of equipment and careful readjustments. Most important is the setting of the tool which forms the ware in the mold. The stoneware maker calls this tool a rib. If the rib is not set correctly and secured tightly the ware will have thick and thin walls and bottoms. After each setting of a rib the ware should be tested by cutting a piece in two with a wire to observe the thickness.

Correct design of the rib is essential, as the shape of the rib determines the inside contour of the ware and the uniformity of thickness of the wall. At this plant a cardboard pattern is made by cutting and adjusting to the mold. The rib is then made by the mechanic, by cutting galvanized iron plate to the desired shape and securing it to a wooden form by screws. The rib is then tested by a jiggerman and the edge filed to the final shape. When ribs are to be used for long periods of time under constant conditions they are made of cast iron.

Drying

The jiggered ware is dried over night in the molds in a hot floor steam drier at a temperature of 130°F. It is then removed from the

molds, finished, and stacked on the drier floor for final drying. The principal trouble is cracking of the rim due to that part drying first as the piece rests in the mold. Cracking may be prevented by covering the mold with a piece of cardboard that has an opening in the center for escape of moisture. Sometimes ware sticks in the molds and breaks in releasing. This difficulty is overcome by dipping the molds in a light oil.

Ordinary tall jars, 5 to 20 gallon sizes, are made in this plant by turning. In large plants they are made in steel dies or plaster molds. Turning is economical for the small plant provided skilled workmen can be secured. At this plant the turned ware is well shaped and sized, and suffers practically no loss by cracking. The process consists of forming the ware by hand on a revolving wheelhead from a prepared and weighed bat of clay. The jars are removed from the wheelhead and placed on pallets. Circular plaster straighteners are placed on top of the jars to prevent warping. The ware is dried thus the first night, then turned top down for final drying.

Glazing

Glazing is done by dipping, rolling, and pumping. Most of the ware is glazed by dipping, in the same manner as any kind of one-fire ware. Stilts are not used much in firing, hence the glaze must be scraped off a top or bottom rim to prevent sticking.

The glazer had encountered some difficulty in setting his glaze to the desired weight. He was given a small balance and a pint measure, which equipment solved his problem. The hydrometer and the viscosimeter are not necessary instruments where the glaze is not applied by spraying.

Rolling is a kind of dipping used for large jars and jugs. The jar is let down into the glaze in an inclined position, to a sufficient depth to allow the glaze to cover all parts inside and out, and then given one or two revolutions with the hand to obtain a uniform coating of glaze. Jugs are rolled in the same manner, the glaze being applied to the outside surface up to the shoulder. The top is dipped in brown glaze and the inside is coated with brown glaze by use of the pump.

In a small plant the glazer occupies a position of considerable responsibility. He has contact with the jiggering and drying processes on the one hand, and the firing on the other. He acts as greenware inspector and rejects defective ware. He must see that the ware is properly finished to prevent sticking in the kiln. Lids, of which many are made for this kind of ware, must be fit in the green to prevent lack of proper-sized lids when shipments are made. Special jobs must be properly made, stamped, glazed, and gotten out on time.

Kilns and Firing

The ware formerly came from the kilns cracked, blue colored, speckled, and stuck together. There was a large percentage of culls and seconds. It was almost impossible to attain the desired heat, cone 7. Dirty coal and lack of draft were the main causes.

The kilns are of a type common in stoneware plants. They are downdraft, 17 feet in diameter at the bagwall, and 10 feet high at the center. The bagwall is continuous and 4½ feet high. There are 8 fire boxes with a total grate area of 36 square feet. The floors are covered with standard floor brick. Feather walls underlie the entire floor. They are 21 inches deep, 4½ inches wide, 12 inch center, and lead perpendicularly into a diametral main flue which is connected with the stack by two 18 inch flues. This arrangement of flues is known as the "single V" type.

The following structural changes were made. The feather walls were changed from checker work to solid wall, mainly to prevent them falling over, a frequent previous occurrence. New floor brick were properly laid. The brick had been formerly laid upside down. Bagwalls were rebuilt and the width increased to nine inches. They had formerly been laid a single brick in thickness and had warped, cracked, and fallen, causing irregular firing conditions and broken ware. The outside walls of the kilns were plastered with cement mortar to close many cracks which extended entirely through the wall. The slanting grate bars were raised eight inches at the lower end where they had previously rested on the floor, making almost impossible the cleaning of fires. No changes were made in the stack, which is forty feet high and divided into four flues.

Setting The method of setting the ware was changed to make the kiln space more open for passage of the combustion gases. To prevent blocking the floor openings, the circular bats used under each stand of ware, are kept two or three inches above the floor by use of brick bats as well as plastic wads.

In round kilns stoneware is set in "rings." The "first ring" is the one next to the bagwall. Succeeding "rings" are set until there remains an irregular space extending from the center to the door. This space is filled by "backing out." Whenever possible each "ring" is set with ware of one kind and size. Most of the ware is set top down. Milk pans and similar pieces are nested. The common shoulder jug is set upright with an inverted butter crock over it, on which rests the next jug. Tall jars are inverted and stacked. Whenever possible smaller ware is placed inside the larger ware. This procedure possesses the double advantage of larger kiln load and clean "inside" ware. Efficient setting of stoneware requires skill and experience. The ware must be set in

the proper "ring"; the maximum "inside" ware must be placed; the stands must be chucked securely with clay to prevent falling over.

Firing Construction and setting having been improved; the firing process received some much-needed attention. The Kansas soft coal in use produced in the kiln a smoky sulphurous condition, causing the ware to come out blue and speckled. To prevent this discoloration the greenware was being set in fired jars used as saggers, cutting down kiln capacity 25%. The Kansas coal was replaced by a clean coal from Franklin County, Illinois. With this fuel the ware comes out clean and white, and no saggers are used.

The main features of the firing process are as follows. Fires are maintained in four fire boxes the first 12 hours, then the remaining four boxes are lighted. At 1200°F a peek-hole above each fire box is opened and kept so until the finish. This allows cool air to enter and hold back the temperature of the top ware and aid in maintaining oxidizing conditions. Above 1900°F coal is placed on the fires every 15 to 20 minutes. At this stage of firing the fire box is full of hot coals except for small spaces beneath the inclined grates and at the top next to the arch. The top opening above the coal bed is kept almost closed by chunks of coal. After firing around, the fireman retraces his steps making openings enough through the coal to let in sufficient air to eliminate the long yellow tongues of flame in the kiln. It is the yellow flame (reducing condition) that causes the ware to turn blue.

The principal cause of the fireman's "fight for the heat" had been the failure to open the bottom of the firebed at the lower end of the inclined grates. This was especially true when the coal slagged more than usual, cutting off the air supply through the grates. In the latter case it is sometimes necessary to break up the entire firebed, but generally it is sufficient to make a small opening at the bottom of the inclined grates. In any case it is hard hot work and the firemen often have to be driven to it.

But constant care and perseverance kept the kiln conditions uniform and made possible attainment of the final and maturing heat treatment. Cone 6 is brought down at the floor and cone 7 at the top of the door. Occasionally the ware as set smothers the bottom cone, which is then given no further consideration. Formerly the firemen spent hours trying to put down smothered cones, generally without success. On one occasion a kiln was fired twenty-four hours after the top cone went down. This treatment caused most of the bagwall and half the ware to fall over. The use of trial pieces was discontinued. They always came good and were of no assistance in finishing the kiln. The cones and the pyrometer are sufficient. The total time of firing is sixty hours.

Kilns and Firing

The ware formerly came from the kilns cracked, blue colored, speckled, and stuck together. There was a large percentage of culls and seconds. It was almost impossible to attain the desired heat, cone 7. Dirty coal and lack of draft were the main causes.

The kilns are of a type common in stoneware plants. They are downdraft, 17 feet in diameter at the bagwall, and 10 feet high at the center. The bagwall is continuous and $4^1/_2$ feet high. There are 8 fire boxes with a total grate area of 36 square feet. The floors are covered with standard floor brick. Feather walls underlie the entire floor. They are 21 inches deep, $4^1/_2$ inches wide, 12 inch center, and lead perpendicularly into a diametral main flue which is connected with the stack by two 18 inch flues. This arrangement of flues is known as the "single V" type.

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Cooling and Dunting

After the final heat has been attained and the kiln tightly closed, the next task is to keep it closed until the ware has been safely cooled. In a small plant every kiln has some "rush ware" in it. Opening a kiln too soon causes dunting, a kind of cracking which often occurs at the time, but sometimes not until months later. This is proved by noting dunted ware in storage piles and in use in the household. The writer has taken home some fine looking ware and has put it through the practical test of time and use. Some pieces are still perfect after two years use. Others have suffered delayed dunting, the cracks generally extending radially from the edge toward the center. The ware can generally be used for a long time after dunting appears, as the cracks open slowly. When a dish is broken the presence of a dunt can be detected by the smoothness of the fractured surface. An ordinary break has a rough surface.

Dunting of ware in this plant is believed due to the following causes: (1) rapid cooling below red heat, (2) body immature, and (3) improper greenware processing.

These conditions are subject to control. The safe rate of cooling can be found by observation. The body should contain enough fluxing materials to produce a condition approaching vitrification, the absorption being not over 2 or 3%. Dfeective greenware processing is a trouble which is sometimes hard to detect. For example, there was considerable loss of five-gallon jugs by dunting. Other large ware fired with the jugs did not dunt. The cause was traced to the jiggering department. The jugs were being strained by removal from the mold and finishing in too soft a condition.

Molds

The molds found at this plant were all defective in some respect. Many had cracked radially when left empty in the drier. Most of them had become so worn with use that they were loose in the jiggering rings and produced ware with thick and thin walls.

Improper design had caused off-size ware, lids that did not fit, ware that hung in the mold, ware that did not nest. Several hundred milk pan molds were found which had a sharp angle at the rim shoulder, causing the pans to crack at the rim while still in the mold. The molds were made usable by scraping off the sharp edge.

A skilled model maker was secured to make new designs and replace the entire stock of molds. The mold storage room was emptied, all of the old molds being thrown away. The drier racks were then checked daily and all molds not in use were moved at once to storage.

Flower Pot Processing

A Baird machine is used for pressing. A lump of clay is dropped into a steel mold which remains stationary while a revolving steel die descends and forms the pot. A cam shaft then lifts the mold sufficiently to allow the pot to be lifted out by hand. The steel die descends 18 times per minute, although a perfect pot is not produced every time. A crew of two men, pugging their own clay, make 2000 to 10,000 pots per 8-hour day depending on the size.

If the clay contains coarse-grained material, it should be fine-ground or blunged and passed through a 40-mesh screen. Pebbles cut the dies and cause speckled, bloated, and cracked ware. The clay has to be pugged to different consistencies for the various sizes of pots. Lubrication is effected by pouring a mixture of die oil and kerosene onto the clay in the pug mill. The machine adjustments must be carefully made and maintained, or ill-shaped ware will be produced.

Machine-made pots are dried on movable boards in racks over steam pipes. The ware must be handled carefully as it deforms easily. When dry the pot is trimmed by placing it in a revolving churn and scraping the rim with a small piece of watch-spring steel. Too much speed in this process results in many broken and chipped pots. After trimming, the pots are nested in wooden crates for ease of handling to the kilns.

In this plant, pots larger than 5 inches in diameter are made in plaster molds in the same manner as stoneware. Hence the manufacture of stoneware and flower pots in one plant is an economical procedure.

Flower pots are nested in the kiln and fired to a temperature of 1750°F in 60 hours, the temperature being determined by thermocouple only. The kiln is of the same size as the stoneware kilns. Kansas coal is used as the fuel, since the sulphur and dust do not injure the flower pots.

Gardenware

Gardenware, such as vases, bird baths, porch boxes, etc., is made in plaster molds of stoneware clay or flower pot clay as desired. The ware is made by jiggering, casting, or pressing, depending on shape and size, and the processing develops some interesting problems for the ceramist.

UNIONVILLE, MICH.

THE PHYSICAL STRUCTURE OF REFRACTORY MATERIALS[1]

By Thomas S. Curtis[2]

ABSTRACT

The relation of physical structure to the performance characteristics is pointed out. It is shown that chemical composition is of value principally as a means of control of raw materials, the value of the end product being determined largely by the crystallographic relationship existing between grain and bond.

To present this subject in logical sequence, and to facilitate its study, the text is subdivided into three sections, each dealing with a particular ceramic ware:

(1) High-fire refractory bodies such as heavy-duty fire brick for boilers settings, etc., flux line glass tank blocks, etc., in which the development of mullite is carried to a very high degree.

(2) Low-fire refractory bodies, such as saggers, glass tank specialties, etc., in which mullite plays a relatively unimportant part.

(3) Vitrified stoneware, whiteware, sanitary ware, and porcelain fired to temperatures that do not bring about the development of mullite except as an incidental inclusion within a globule of fused feldspar.

The technique of natural color photography and photomicrography was published in August, as a means of preserving a faithful and permanent record of the structures shown under the microscope.[3]

A petrographic study of the structures of these bodies is not made. The sole aim is to depict the physical relationship between the aggregate or grog and the matrix or bond.

This investigation has demonstrated rather conclusively the importance of correct grain sizing, the release of strains, and the proper pugging or conditioning methods.

Crystal structure is discussed only in those cases wherein it is possible to show advantages of the recently discovered properties of certain crystallographic forms of the mineral mullite.

High Fire Bodies

Under this heading are those refractory bodies which in service are subjected to high temperatures and which contend with highly corrosive slags at high temperatures. The discussion is confined solely to aluminum silicate refractories of the fireclay, diaspore, or mullite class.

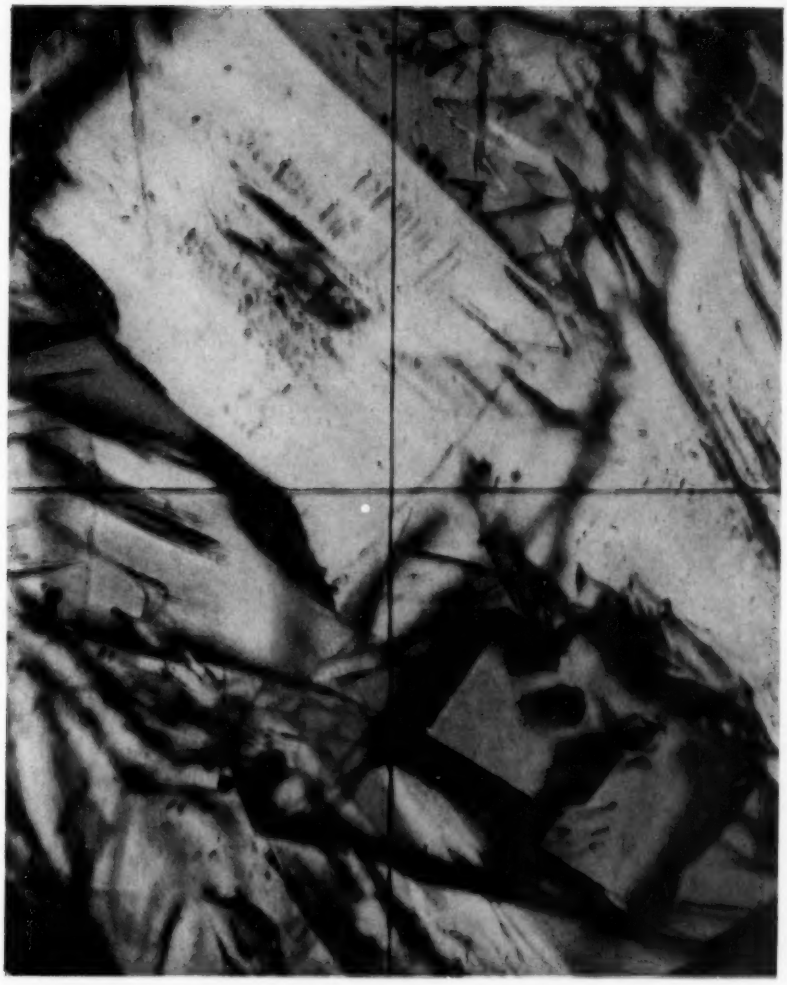
Constancy of Volume

When any mixture of alumina and silica is heated to the point where a condition of pasty fluidity is obtained the mullite reaction results, providing that the admixture of the two materials be sufficiently thorough, *i.e.*, that the particles be

[1] Preprinted and presented in Paris, France, May, 1928.

[2] Director of Research, Vitrefrax Corporation, Los Angeles, Calif.

[3] T. S. Curtis, "Photomicrography in Natural Color," *Jour. Amer. Ceram. Soc.*, **11** [8], 609–32 (1928).



COLOR PLATE I.—DUROX-REFRACTORY GRADE (massive electric furnace mullite). Photomicrograph in natural colors, made by Curtis Bromoil Process, using Wratten "M" Panchromatic Plates, Electric Arc Light, A, B, and C Filters, with Bausch & Lomb Petrographic Microscope. Magnification 300 diameters crossed nicols, with first order red (selenite) plate inserted to bring out glassy areas in solid red values. The picture is done in permanent oil pigment, with nine impressions, there having been three impressions in register for each color, to retain highlight, detail, and shadow values. The specimen used for the photomicrograph was a thin section of normal Durox-RG ingot. The chemical composition is in the ratio of 72.0% Al_2O_3 to 28.0% SiO_2 with 3% total RO content. Chief interest lies in the massive mullite formation, the small amount of glass in which the fibrous crystals of mullite used as bond strengtheners are readily discerned, and in the very nearly perfect section through a single massive crystal shown in the southeast corner of the field. The total absence of corundum is also of note.

COLOR PLATE II.—DUROX-CERAMIC GRADE (fibrous electric furnace mullite. For technical data regarding the print, see caption on Plate I. The details of procedure are the same for both prints. The specimen is a thin section of normal Durox-CG ingot. Chemical composition is in the ratio of 72.0% Al_2O_3 to 28.0% SiO_2 with 4% RO content. The marked departure from the order of crystallization shown in the companion print is of interest in that it discloses an abundant yield of fiber, with the desired percentage of slender but massive crystal, as well as the inclusion of three plates of corundum in the southwest field. The percentage of glass is very much higher than in the case of the RG specimen, which accounts for the presence of the corundum, the total composition, chemically, being the same in the two specimens. The pictures are of interest in that they well illustrate the wide differences which may occur in a synthetic mineral having a uniform chemical analysis. These variations in the structure have a profound influence upon the behavior of the mineral in practical service. The crystalline habits of the end product have been placed under remarkably close control through a study of the effects of the fluidity of the molten bath, rate of cooling, the use of, or the careful prevention of vibrations of the mass while cooling, a combination of both vibration and rest periods during the cooling cycle, etc., etc.

of sufficiently small size to permit of a homogeneous solution. On cooling, the mass crystallizes in part or as a whole, into long, square-section shafts of the mineral mullite, ($3Al_2O_3:2SiO_2$ or 72% alumina to 28% silica).

Whether the melt crystallizes out into practically 100% of mullite, or whether it represents a mixture of mullite and glass, or mullite, corundum, and glass, depends, (1) upon the original composition of the mixture, (2) upon the temperature to which the mass is heated, and linked with this, of course, the percentage of flux in the mixture, and (3) upon the rate of cooling of the fluid or pasty mass. Degree of fluidity, and the nature of the atmosphere in which the melt is formed are contributory influences.

In Plates I and II is a graphic illustration of the wide differences that may occur in two successive melts of practically the same chemical composition with no change in technique other than cooling rate. On a four-ton ingot of each specimen, the cooling rate in the massive mullite, Plate I, was four times as long as that employed in the ingot represented by Plate II. The characteristics of the two end products are widely dissimilar.

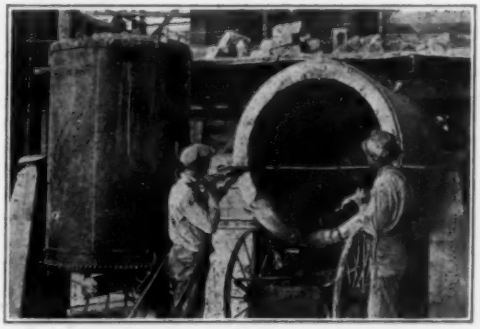


FIG. 1.—The converter in position for unloading. A later model, holding five tons per charge, describes a 180° rotation and automatically dumps its charge into a pit from which a one-ton grab bucket picks up the crystallized mass, feeding it to the crusher hoppers.

The flat statement may be made that while the Plate I material when bonded with the proper intermediate types of mullite is splendidly adapted to the formation of dense, slag-resisting flux-line glasshouse refractories, it is of no value whatsoever as a fine aggregate in high-fire porcelains, for in porcelain the fine grains of splintered mullite would resist fusion and serve more as refractory aggregates in the body.

If the type of aggregate in Plate II is employed in a refractory mass, the additional glass and excess of widely-separated slender mullite shafts fall an easy prey to alkaline silicates. But this very same property makes it possible to produce of the Plate II material a very hard, tough, and dependable porcelain at approximately cone 20. Such a porcelain has given excellent service as a liner material in mills and for grinding balls.

Chemical composition, while important, is of secondary interest to the technique of manufacture of the mullite grain itself. Heavy-duty

refractories must, primarily, be relatively inexpensive. Electric furnace mullite, which stands in a class by itself for glasshouse refractories, is not only too costly for use in high-rating boiler refractories, but it is actually not as satisfactory as mullite made in a natural gas converter at a temperature of approximately cone 32. Fifty tons per day of the latter material are being manufactured at a cost not greatly in excess of that of virgin clay grog fired in downdraft kilns.

Plates III and IV show some of the reasons why the converted product is more satisfactory for heavy-duty refractories of the boiler setting class. Such brick must have great constancy of volume at increasing temperatures and under conditions of extreme reduction from sulphur and carbon gases. It must have a high resistance to spalling after surface vitrification has set in and must cut well for the bricklayer without serious weakening of the remaining structure. It must have sufficient porosity to permit of elasticity in its structure in order that its surface may be rapidly heated without checking or spalling in the initial heating up; at the same time, it must have sufficient compactness and density to resist at least to a degree the penetration of destructive reducing atmospheres after it has been coated with either a natural or an applied glaze.

These conditions are apparently well achieved in the brick structure shown in Plate IV. It shows the type of crystallization that permits the use of relatively cheap raw materials with alumina content of from 52 to 55%. The crystals are so completely interlocked that the glass content is rendered harmless since it is imprisoned in the interstices between the mullite shafts. A ground cylinder of this aggregate or grog is perfectly rigid under a load of 25 lbs. per square inch at cone 32 both under reducing and oxidizing conditions.[3]

[3] In passing it may be well to point out the influences that play a part in causing shrinkage, deformation, and vitrification spalling, the bugbears in most mechanical oil-burner boiler furnaces.

If manufactured from porous grog and bonding clay a brick will change its volume continuously under service conditions. As shrinkage ensues, the cracks opening up between brick in the wall constantly expose increasingly greater areas of the brick to attack. Finally surface vitrification ensues and upon cooling down or again heating up, the face of the brick pops off, thus exposing a fresh area to repeated attack.

It is an inherent property of crystalline materials to be rigid under loads at high temperature, and of amorphous materials to deform. An amorphous material has been defined by Washburn as a "solid liquid" which definition is singularly appropos in the present case. Glass is the common example of amorphous material. On the other hand, if we use grog of the proper size and completely inverted to its maximum content of mullite, and if we keep the size of the crystals and their orientation of such an order that an intergrowth of crystals is encouraged between the large grains and the surrounding smaller grains and the bonding clay, then we shall have a structure that is dependent to a far less extent upon the cementitious action of the glass in the bond, and is influenced to a much greater degree by the presence of microscopic crystals in the matrix immediately adjacent to the grains.

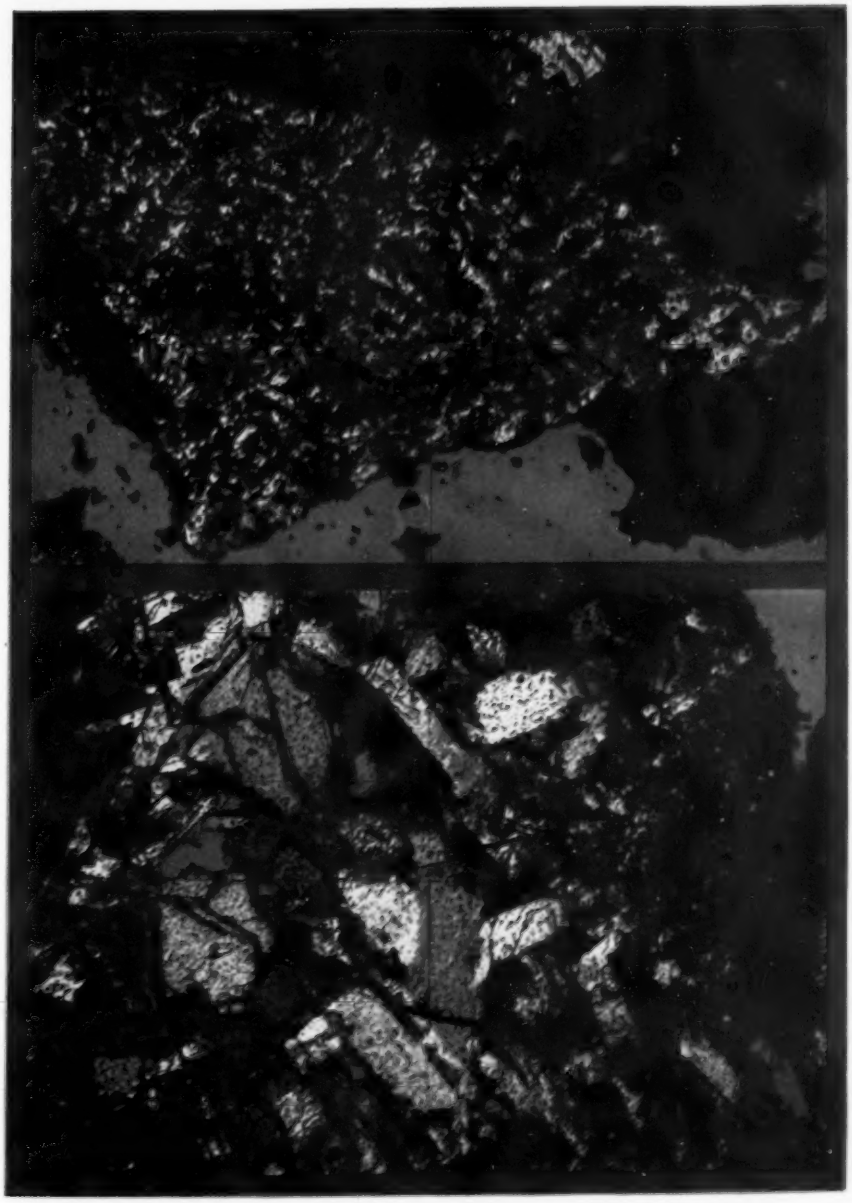


PLATE III (above) PLATE IV (below)

COLOR PLATE III.—Thin section through converter mullite grain produced at cone 26, and representing the minimum degree of crystallization and size of crystals that has been found permissible for the production of a heavy duty refractory. Photographed with B. & L. Apochromat at 375 ×, between crossed nicols and with selenite plate. Solid red areas represent pore spaces or voids in brick structure.

COLOR PLATE IV.—Thin section through grain of converter mullite grog in Argon brick, showing the desired structure in a heavy-duty refractory as produced at from cones 30 to 32. The complete attachment by means of intergrown crystals at the periphery of the grog grain is of interest in that such attachment promotes great rigidity in the brick under load at high temperature, and, if sufficient elasticity is preserved by means of suitable pore spaces, results in very high vitrification-spalling resistance as compared with the structure shown in Plate III. 375 ×, crossed nicols, selenite plate.

The degree of crystallization in Plate IV is not essential for the entire brick structure if anything short of the best is good enough in the desired product. In Plate III we see a complete crystallization of the grain of grog, which may be obtained at as low a temperature as cone 26. This grog is just as rigid when tested by itself as a unit as is that shown in Plate IV. But it does not encourage any degree of interlocking with the surrounding bonding matrix, if the brick be

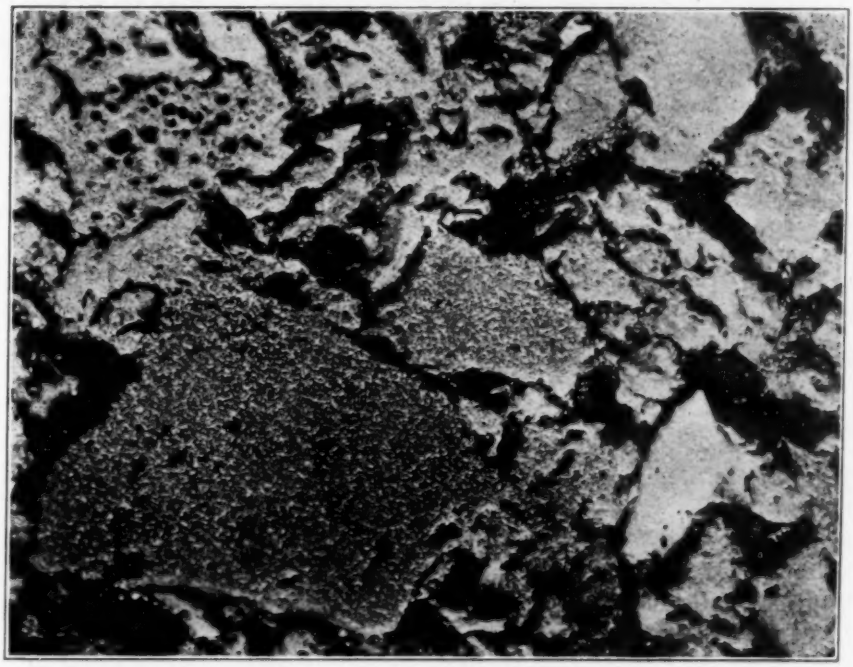


FIG. 2.—Ground surface of mullite brick, showing the excellent gradation of grain sizes, and freedom from manufacturing flaws. The highly crystalline nature of the grog grains is also well shown. Surface prepared by grinding with No. 80 Carborundum grain, to dig out bond and render hydrofluoric acid etching unnecessary.

fired at cones 17 to 20. If the brick is to be fired at cones 26 to 28 then the Plate III product is fully equal to the Plate IV variety. Manifestly it is much cheaper and more satisfactory to produce the coarsely crystallized grog and have the advantage of the better structure it produces in the resultant brick.

Glasshouse Refractories

A glass batch of low salt-cake content, requires a different structured refractory from one that will give good service on high salt-cake

batches. This is the principal problem of super-refractories for glass-house service.

Unlike the requirements of the heavy-duty boiler brick, the flux line block is called upon to bear very little load, and the temperatures of service are very much lower. While spalling resistance is desired, it is not at all paramount since the glass tank is large and usually covered with a silica roof which makes it incumbent upon the operator to pre-heat very slowly to avoid damage to the superstructure.

On the other hand, the tank block must resist the attack of most highly corrosive melts. This service predicates a tank block structure of fine grain and of great apparent density.

This requirement is met to a remarkably high degree in well made fireclay tank blocks, but it has been proven that true mullite crystals exhibit the very highest resistance to baths high in salt-cake content. Therefore, mullite makes an ideal flux block.

But there are some twenty different types of mullite crystallization. Every one of them is a bundle of either large or small or microscopic shafts, bound together with glass. And it makes a vast difference in their behavior whether the crystals lie nested together in parallel bunches, which are ready to separate into tiny needles under the influence of a powerful solvent, or whether they are piled together in a conglomerate mass, not unlike the shafts of wood in a log jam, the interstices of the mullite shafts being filled with glass, while those of the logs are filled with water. The mullite crystal itself is highly resistant to the solvent action of the materials of the glass batch, while the interstitial glass between the mullite shafts is readily dissolved.

Again we have two alternatives in our manufacturing procedure. The first is to melt the entire batch, pouring the fluid into molds of the desired shape to form tank blocks, and depending upon careful control of the cooling rate to bring about the desired crystallization and to release the strains within the cooling mass by annealing. This procedure presents a terrific problem of manufacturing technique which has apparently been solved by one of the progressive manufacturers of tank refractories.

The other alternative is to simulate the ideal structure by a conglomerate mass of properly sized and properly crystallized fragments of pure mullite so graded as to permit and encourage recrystallization within the mass at temperatures from cone 18 to 26. Which of these alternatives is the better will have to wait the test of time, but the experience of the past four years in commercial service has demonstrated the ability of the recrystallized block to survive two and three ordinary campaigns as against the single campaign of the ordinary clay flux block, which justifies the higher cost of the mullite block.

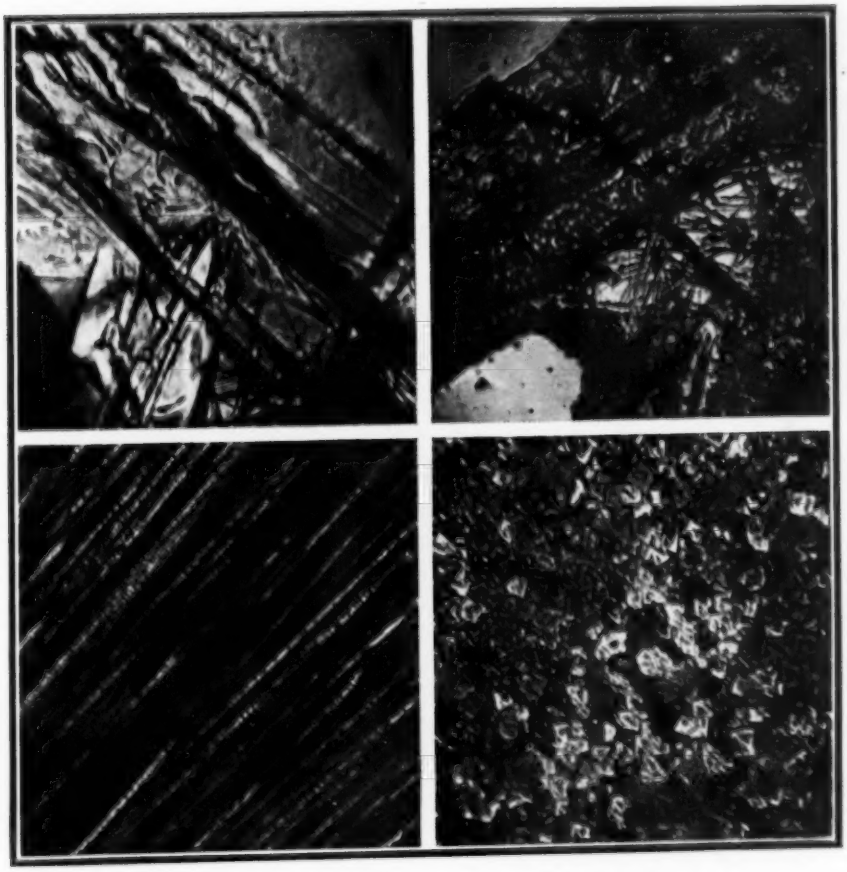


PLATE V (above)
PLATE VII (below)

PLATE VIII (above)
PLATE VI (below)

COLOR PLATE V.—Thin section through grain of massive electric furnace mullite as used in the major aggregate of Durox glass tank refractories. The massive crystals are interspersed with small glassy areas in which fine mullite needles are grown. The fragment of the massive crystal is extremely insoluble in most commercial glass melts. 375×, parallel nicols.

COLOR PLATE VI.—Basal section of electric furnace mullite used as bond of Durox glass tank refractories. The closely packed fine shafts of mullite fracture in bundles and to some extent into shafts, most of which have a trace of their original glassy coating remaining. The impalpable flour used as the bond readily recrystallizes in the interstices between the large grains of massive mullite, forming a matrix almost as resistant to the attack of molten glass as are the massive fragments themselves. 375×, crossed nicols, selenite plate.

COLOR PLATE VII.—Longitudinal section of the same specimen shown in Color Plate VI. This picture well illustrates the marked uniformity of the mullite formation and demonstrates how the mass may be crushed and ground without entirely destroying the shaft-like structure of the original crystals. 375×, crossed nicols, selenite plate.

COLOR PLATE VIII.—A beautiful delineation of the effect of using a certain type of crystal for the grog and another for the bond is well exhibited in this thin section through a recrystallized Durox glass tank block. The fragment of massive mullite is shown completely tied in to the recrystallized matrix of finer crystals illustrated in Color Plates VII and VIII. The photograph was made at 1000 diameters, with B. & L. 4 mm. Adjustable Apochromat, 12.5× compensating eyepiece, with camera extended to give required magnification. The selenite plate was inserted and nicols partially crossed, while stage was rotated to point of maximum general illumination.

The mullite tank block is made from a batch consisting essentially of large and intermediate fragments of the electric furnace mullite shown by Plate V with the interstices filled with progressively smaller fragments of the parallel crystallization shown by Plates VI and VII which were cut from the same specimen of the product with the sections taken ninety degrees apart. It has been found that this finely crystallized mullite, with its uniform structure and closely controlled glass content readily promotes recrystallization in the matrix surrounding the massive fragments. This characteristic is well brought out in

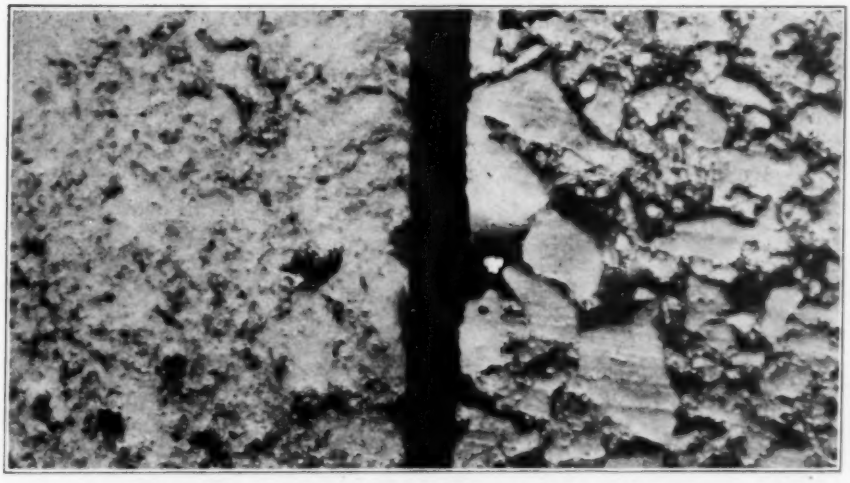


FIG. 3.—To the right is shown a ground surface of a high grade clay glass tank flux block, while to the left may be seen a mullite block. Note the difference in size and shape of the pore spaces. While both specimens have approximately the same absorption in water, the block to the left has but a fraction of the tendency to absorb viscous molten glass owing to its fine pores and the fact that many of them cannot be penetrated by a fluid of high viscosity.

Plate VIII which represents a thin section through a tank block with the field selected to show a section of a single massive mullite fragment surrounded by and locked to the highly crystallized matrix.

The high resistance to the solvent action of the glass batch and the raw materials of its composition is explained partially by this intercrystalline structure, and partially by the actual mechanical make up (see Fig. 3).

It has been demonstrated that the solvent action of the batch and of the molten glass is very much decreased as the percentage of voids is decreased. This fact also holds true if the voids be made so small as to resist penetration of the rather viscous fluid of the metal. Therefore, it is to be expected that the greater apparent density of the mullite

block would be conducive to longer life. Added to this obvious advantage, is the fact that the very backbone of the structure is composed of an aggregate of pure mullite crystal fragments which are highly insoluble in glass melts as compared with ordinary porous clay grog. Finally, this insoluble aggregate is held entrapped in a mass of interlocking mullite crystals that again are cemented together with glass. The result is that the conglomerate of fine mullite crystals in the bond or glass serve to retard the solution of the latter by the metal of the glass tank, and actually bring about such a slow erosion that bond and aggregate dissolve together, with rarely a case of a mullite fragment being precipitated into the metal to form a stone.

Low Temperature Refractories, Saggers, etc.

There is a wide field of service wherein the ultimate temperature to be employed never exceeds cone 14. There is no necessity for using a mullite refractory in such a service, since the cost is inordinately high and the results no better, if as good, than can be obtained with much less expensive materials.

It was realized that the great strength of true mullite bodies was due to the interlocking fibrous network within the mass, which network provided a reinforcement that was totally lacking in the ordinary, low-fire ceramic body whether it be of the vitreous or the porous class.

It was also realized that the production of such an interlocking network would be out of the question by thermo-chemical means in the average low-fire ceramic structure, since the temperatures employed would serve only to produce the merest semblance of barely discernible mullite needles, even at the highest resolving powers of the microscope.

It therefore became evident that if we are to relieve or remove the tendency to brittleness of a ceramic body, we must find a mineral fiber that would be inert in its chemical relationship to the clay of the body, which immediately eliminated asbestos since it does not possess either the characteristic of chemical inertness nor does it have sustained strength at temperatures of cones 5 to 14.

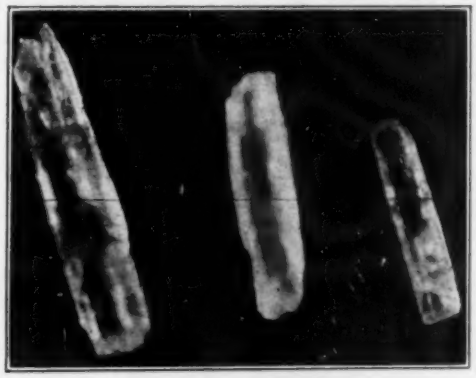
Synthetic mullite needles would serve admirably as such an aggregate of fibrous form but they would be hopelessly too expensive. Natural sillimanite meets the requirements, but true sillimanite is so rare as to be classed as a specimen for the mineralogical collection. The so-called sillimanite from abroad is not sillimanite of the type required and will not function.

The mineral andalusite is useless for the purpose for the reason that it breaks into angular fragments of no definite shape. Dumortierite is in the same class and useless for the purpose.

Fibrous pyrophyllite and kyanite alone have the desired structure. The former occurs in the necessary form in only one known deposit, while the latter is fairly widespread in its occurrence, but limited also to one known deposit wherein the desired properties of the mineral are found. This is not unusual in the mineral field, since parallel cases are to be found in many industries that depend upon a rather common mineral having properties peculiar to one deposit caused by the environment surrounding its occurrence in nature.

Characteristics of Kyanite

It was found that while finely ground kyanite certainly had the desired fibrous shape, it also had other properties that rendered it practically useless for the purpose in mind and that its sole virtue lay in the fact that it counteracted shrinkage to some extent when added to a ceramic body.

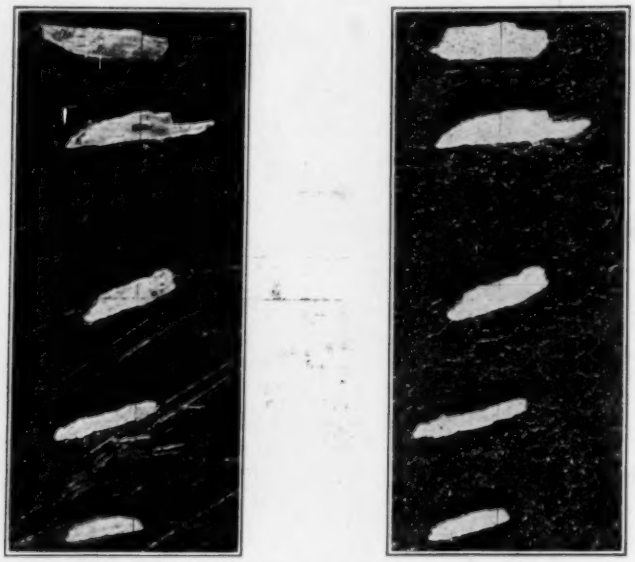


FIGS. 4 and 5.—Crystals of ground, but untreated, kyanite which have passed a 100-mesh screen, once, but were caught the second time, shown above, while Fig. 5 below, shows the results of firing the smallest crystal, at the top, to cone 14. The larger crystals virtually exploded and flew out of the platinum pan.

For examination of the thermal characteristics of kyanite, individual fibers ranging from those that would pass a 100-mesh screen to those that were retained on a 200-mesh screen, were lifted by means of a micromanipulator and placed side by side on a platinum dish about one-half inch in area. The dish was then placed in a small electric furnace and heated to temperatures represented by cones 5 to 14 inclusive. After each cone had gone down, the dish was removed and the specimens examined under a stereo-binocular microscope which clearly brought out the heat effects as they progressed.

In practically every case, the natural crystal fiber, which is shown by three specimens lying on the platinum dish in Fig. 4, virtually exploded to the shapes as shown in Fig. 5 which shows the same dish and the remains of the small fiber after heating to cone 14.

This obviously explained the reason for the erratic behavior of the natural kyanite when it was made a part of a ceramic body. It also served to give a clue to the solution of the problem which solution has resulted in the introduction of a manufactured product under the

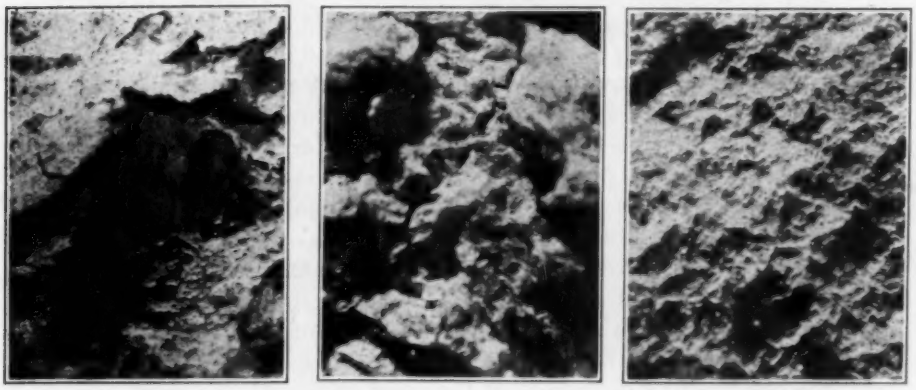


FIGS. 6 and 7.—Crystals of specially treated kyanite, manufactured into Vitrox (Patents Pending) are shown to the left in the condition in which they are shipped, but prior to reheating. To the right, Fig. 7, may be seen the same five crystals after heating to Cone 14 in the same furnace as those illustrated in Figs. 4 and 5. Note the complete stability of size and shape. Photographed at 100-× as in Figs. 4 and 5.

trade mark Vitrox, which, while made from kyanite, is not kyanite, nor does it bear any relationship to it in its physical properties, although optically it cannot be distinguished from the latter except for a decided change in the cleavage tendencies.

Figure 6 shows five fibers of Vitrox lying upon the platinum dish as they appeared before firing, but after having been put through the Vitrox process of manufacture. In Fig. 7 may be seen the same five Vitrox fibers after they have been fired to cone 14. It will be noted that the bursting and disintegration indicated in the case of the natural kyanite is totally missing in the Vitrox, the original shape and even the position on the platinum dish having remained unchanged throughout the heat treatment.

Plates IX, X, and XI clearly show that a decided change in the physical structure of the original kyanite fiber has taken place. In Plate IX may be seen the original kyanite ore to the right, while to the left of the picture may be seen the ore after it has been put through the initial heat treatment of the Vitrox process. Apparently it is unchanged, to the unaided eye, but when the two lumps are ground and screened, and two fibers each typical of its class, are placed upon a slide and examined under the microscope, it is perceived that the natural kyanite fiber (Plate I) has a pronounced cross-fracture with a plate like cleavage. As this fiber is heated, it fractures at the cleavage



FIGS. 8, 9, and 10.—Effect of zero, 10, and 20% of Vitrox in a sagger body used in an Ohio Valley white ware plant. Note the decreasing percentage of weakening flaws as the percentage of fiber increases, also, the better attachment of grog particles in the 10 and 20% bodies. Saggers of this latter batch outlived the original sagger by more than three to one.

planes, and in surrendering to its inherent tendency to grow in the direction of its length, splits apart into fibers of smaller diameter but of badly distorted shape and of weakened physical resistance.

The Vitrox fiber as shown in Plate XI, exhibits very little of the typical cross-fracture of the original cyanite, and consists of a compact mass of parallel fibers. In the manufacturing process the weakness of the original mineral has been turned into an advantage, since it is in this weakness that the solution not only of the problem of producing an inert fiber was found, but, what was equally important, the same reaction places the associated quartz gangue in such a condition that the mineral may be concentrated to any desired degree of purity by simple screening.

The results obtained with this manufactured fiber when it has been added to a low fire refractory or pottery body are at times amazing. Ordinary sagger bodies have in cases been strengthened from 500 to

1000% in resistance to thermal and mechanical shock. Shrinkage strains are reduced to a minimum, not by virtue of any expansion from the Vitrox fiber, since it has practically none as contrasted with the same size of ordinary ground cyanite, but because of the inertness of the splinter which serves to control shrinkage in much the same manner as fine grog. At the same time, the mechanical strength and toughness are increased by reason of the mechanical reinforcement of the fibers within the mass.

In Figs. 8, 9, and 10 may be seen natural fractures photographed under the deep field or stereo-binocular microscope of a typical sagger body, showing the effects of Vitrox inclusions. Figure 8 shows the body without Vitrox, Fig. 9 the body with 10% added, while Fig. 10 shows the effect of 20% of the fiber. The grog sizing and bond are the same in all three, the Vitrox having been pugged into the mass as a percentage addition of the whole body.

Figures 11, 12, and 13 are from ground surfaces of the same three bodies, containing no Vitrox, 10%, and 20%, respectively. It is interesting to note the marked improvement in the degree of attachment of bond to grog in the case of the 20% body.

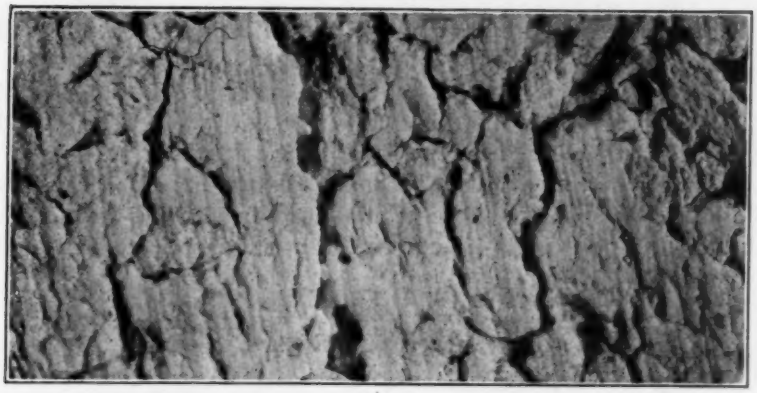
It may be questioned, very naturally, why merely adding fine grog will not accomplish the same result. It will, and so will fine silica sand, insofar as producing a good looking and mechanically sound body is concerned. But both fine grog and sand have a decided tendency to weaken the bonding properties of the bond clay, and this weakness is felt in the resultant body, whereas the mineral fiber serves as a counteractant of shrinkage and at the same time tremendously strengthens the ware.

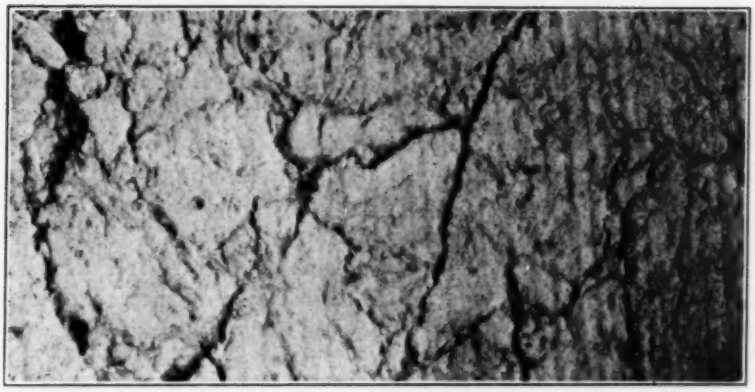
The improvement brought about in the high-fire refractories by means of proper grain sizing and the growth of interlocking mullite structures, is readily achieved at the lower temperature refractories if we substitute a mechanically interlocking mineral fiber for the mullite. Of course the mineral fiber must have the necessary inert properties and freedom from disastrous expansion strains, otherwise it will do more harm than good.

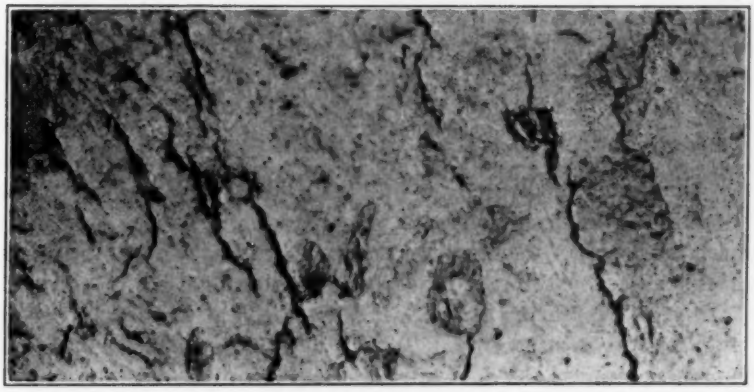
Low-Fire Vitrified Bodies

Plate XII is from a thin section of a German porcelain in which Vitrox has been substituted for a portion of the flint. The Vitrox fiber can readily be discerned by its long, slender shape as contrasted with the irregular grains of quartz appearing against the glassy matrix. The almost perfect imbedding of the fiber within the matrix is of particular interest.

The characteristics of this body are exceedingly high resistance to thermal shock and great impact strength. Plates made of the body will







FIGS. 11, 12, and 13.—Showing ground surfaces of the three sagger bodies shown in Figs. 8, 9, and 10, and containing zero, 10, and 20% of Vitrox, respectively. The improvement in structure is plainly discernible as is also the thorough imbedding of the grog in the bond. It is curious to note that the absorption of the three bodies is practically the same, notwithstanding the vast structural difference.

stand heating over a bare gas flame without the slightest tendency to check.

Experimentally, the practice has shown marked advantage in the case of stoneware, both of the common yellow variety and of the chemical type. It has been possible to increase the resistance to impact of yellow stoneware bowls some 30% while the warpage losses in the kilns have been cut to a minimum. Whether this encouraging result will be borne out in practice on a large scale still remains to be seen.[1]

Summary

In high fire heavy duty refractories designed to withstand loads at high temperatures and under occasionally severely reducing atmospheres, it has been found that a structure created by using a grog of approximately 52% alumina with less than 5% RO, the grog having been inverted completely to mullite and glass with the glass almost wholly within the interstices of the interlocked mullite mass, affords a brick of great constancy of volume, if the grog be bonded with a clay of the same composition and fired to at least cone 17. To obtain maximum stability from this composition, the grog must be crushed to sharp fragments with crystal fractures cleanly exposed; the sizing of the grog must be such that a maximum weight of grog may be packed within the finished volume of the brick, the bond acting merely as a pore filler between grog grains; and the crystallization of the grog must be such as to promote a tendency for interlocking crystals to form at the juncture of the bond. This latter is achieved if the grog be produced at cones 30 to 32 under proper alternations of reduction and strong oxidation.

In low fire refractory bodies in which it is not possible or feasible to recrystallize mullite in the bonding matrix, the use of sized grog with the addition of a small amount (usually 10 to 20%) of an inert mineral fiber, has been found to exert a marked influence upon the rigidity, strength, and toughness of the refractory. The substitution of finely ground quartz or grog has the effect of improving the appearance of the body but results in decreased strength and rigidity in service, both under working temperatures and at room temperature. This is explained by the fact that such dust weakens the bonding clay by diluting its cementing power, whereas the inert mineral fiber acts as a mechanical reinforcement, actually binding together the mass much in the same way as does hair in plaster molds.

In vitreous bodies there is an advantage in careful sizing or proportioning even of the finest grains of the nonplastic addition. Considerably increased strength and toughness, as well as resistance to thermal shock have been attained through the use of the inert mineral fiber mentioned above.

[1] Since this paper was originally presented commercial manufacture of cone 5 stoneware has been effected showing 700% increased strength with 70% reduction in kiln loss.

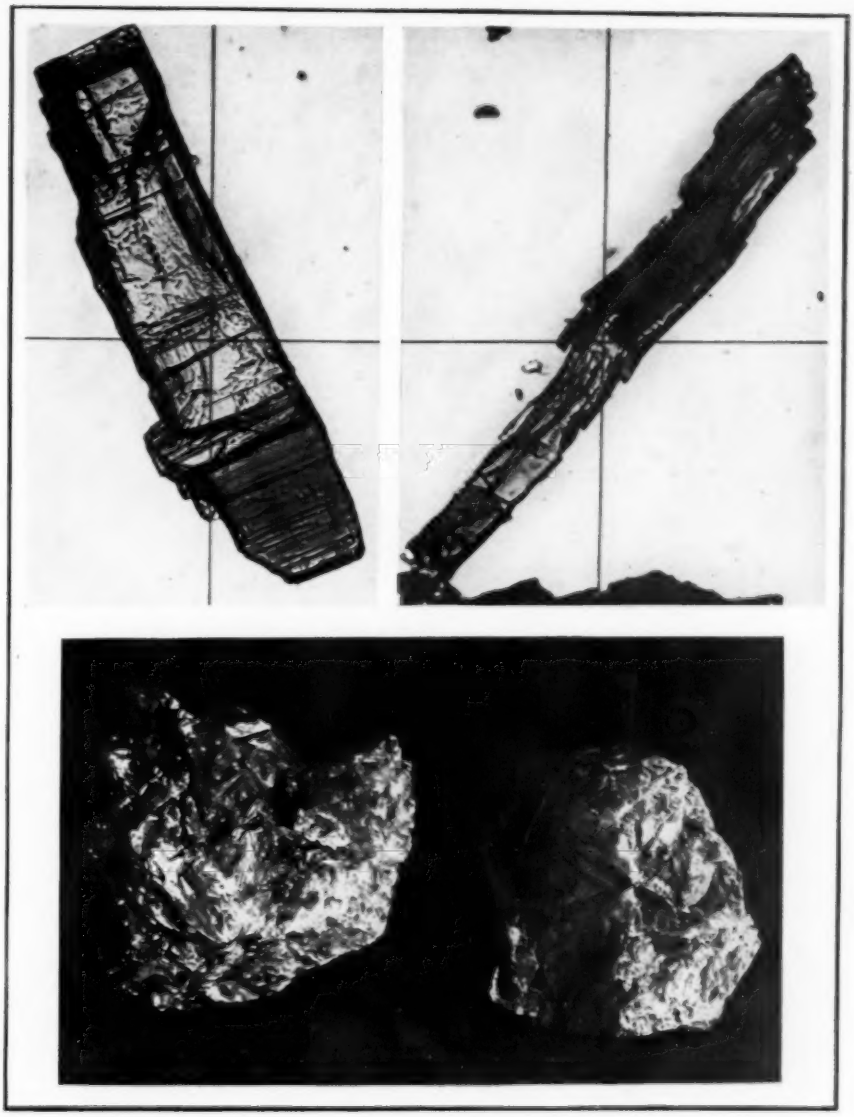


PLATE X (left) PLATE XI (right)

PLATE IX (below)

COLOR PLATE IX.—To the left, a lump of the virgin ore before having passed through the Vitrox process. To the right a similar lump after having been processed for the manufacture of Vitrox. While, to the eye, there has been no visible change, either in color or form, still if seen under the microscope, there will be found a most profound change in the physical structure. See Color Plates X and XI. Natural color photograph made in daylight, on Wratten Panchromatic Plates, with B. & L. Series VIIa Protar, and rendered in permanent carbon trichrome pigment by the process described by the author.

COLOR PLATE X.—Crystal of natural kyanite that has not been put through the Vitrox process, the fiber having been sized through a 100-mesh screen and caught on re-screening, placed on the slide with a micromanipulator to exhibit its plate-like cleavage. On firing such a crystal to a temperature above cone 5 and under cone 15, the strains set up by the natural tendency to elongate, cause the mineral to split along its natural cleavage planes into plates, which in turn, curl apart into distorted fibers. 250×, parallel nicols, selenite plate.

COLOR PLATE XI.—Crystal of Vitrox as shipped in the manufactured product. The original kyanite ore has been put through a process that weakens it to a greater extent in one plane than another, thus in milling the crystals break apart into fibers that consist of bundles of parallel crystals instead of long, slender plates as shown in Plate X. The processed fiber remains virtually unchanged in shape and physical strength when fired to temperatures between cones 5 and 15 and thus may be used as a mineral fiber reinforcement in ceramic bodies to which it imparts great strength. 250×, parallel nicols, selenite plate.

COLOR PLATE XII.—Thin section through German porcelain oven ware strengthened with Vitrox. The latter may be recognized as the long, massive fibers in the northwest and southeast fields.

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Abrasives

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Wheel operation. Anon. *Abrasive Ind.*, **9** [8], 212 (1928).—Conditions affecting the use of wheels vary as the speed of wheel and work, size and shape of pieces ground, composition and temper of metal, method of grinding, condition of machine, etc. Important factors in selecting wheels are the amount of material to be removed and finish desired. If a large amount of material is to be removed by grinding, coarser wheels should be used to facilitate the rapid removal of stock. If a wheel glazes over and cuts slowly, it is too fine or hard. If it wears too fast or wears out of round it is too soft or too coarse. Increasing the speed will make it act like a wheel of a harder grade and decreasing the speed will make it appear softer. The use of a coolant permits the use of a slightly harder wheel and improves the finish. In hand grinding the finish depends upon the fineness of the wheel. In cylindrical grinding it depends on the speed of the work, the speed and condition of the wheel, and the fineness of the wheel. A wheel is most efficient as to grade when it is just soft enough not to glaze and just hard enough not to wear away rapidly. E.P.R.

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and as the data were taken from practical experience in finishing these parts they are timely and interesting. The most economical method is to use one wheel only, truing the wheel very sharp for the roughing operation and very smooth for the finishing. A 200-K carbide of silicon is used successfully for this latter method. As copper is easily ground "out of round," light cuts are necessary. For roughing, cuts 0.0005-inch deep may be taken safely, but for finishing, cuts should not be deeper than 0.00025-inch. E.P.R.

Big demand for wheels in British industries. C. CHRISTIANI. *Abrasive Ind.*, 9 [8], 214 (1928).—Great Britain is in need of modern grinding wheels to replace sandstones in the cutlery and other industries. Due to the progress made in the U. S. in replacing grindstones with huge silicate-bond wheels, there seems to be no good reason why a like procedure is not possible abroad. E.P.R.

Exhibit models. ANON. *Abrasive Ind.*, 9 [8], 222 (1928).—The Carborundum Co., Niagara Falls, N. Y., has a display of abrasive products, in the Gorge Terminal Bldg. E.P.R.

Heading dies are ground rapidly. ANON. *Abrasive Ind.*, 9 [8], 223 (1928).—Cold heading dies should be finished very accurately. The former method of finishing these dies consisted of machining them accurately and after they were hardened the bore was lapped as carefully as possible. By substituting internal grinding for lapping, a great saving is shown as the finishing time is reduced 10 to 35 minutes. Furthermore the work finished by grinding is much more accurate than it is possible to produce by lapping. E.P.R.

Sandpaper makers merge. ANON. *Abrasive Ind.*, 9 [8], 227 (1928).—The Manning Abrasive Co., Inc., Troy, N. Y., and Herman Behr and Co., Inc., Brooklyn, N. Y., now are consolidated under the name of the Behr-Manning Corp. E.P.R.

Diamond dealers merge. ANON. *Abrasive Ind.*, 9 [8], 227 (1928).—The Koebel Diamond Co., Inc., is now associated with Harry W. Wagner who has long been connected with the diamond industry. The new address of the corporation is Canadian Pacific Bldg., 342 Madison Ave., New York. E.P.R.

Cylinder wheels with iron backs. ANON. *Abrasive Ind.*, 9 [9], 236–37 (1928).—There is a growing demand for miscellaneous cylinder wheels mounted on iron backs by using sulphur or other cementing material. If the design of the back is correct and the proper cement is used, this type of mounting is satisfactory for many jobs. In the larger sizes, the price per wheel is less, in addition to the fact that they can be used down to a smaller discarding size. The selection of the cementing medium is of prime importance and there are several factors which must be taken into consideration. The different types of cementing material are: sulphur, lavasul, shellac, Trinidad asphalt, magnesium oxychloride, sodium silicate, and litharge-glycerine. They are discussed in detail. E.P.R.

Roll grinder discards lathe. ANON. *Abrasive Ind.*, 9 [9], 238–39 (1928).—The first cost of a roll turning lathe is far below that of a roll grinding machine, but the economies brought about by grinding more than offset the initial cost of equipment. In the plant of a prominent tin-plate manufacturer one 30x96-inch roll-grinding machine and operator replaced four lathes and operators. Important factors incorporated in the design of this machine make it possible to resurface a 28x34-in. roll removing about $^1/_{16}$ inch from the diameter, with an average grinding cost of 20 cents per roll. E.P.R.

Polishing and plating room layout eliminates backtracking. ANON. *Abrasive Ind.*, 9 [9], 240–42 (1928).—The art of polishing and plating is being gradually reduced to an exact science. The equipment of the new plating and polishing department of the Packard Motor Car Co., Detroit, which is the most modern installation of its kind in the country, is described. The polishing department is equipped with 52 Gardner motor-driven lathes, while 25 Gardner buffing lathes are in operation in the buffing

department. Each unit is electrically driven and the department is fitted with a modern system for carrying away the lint and dust that is present in the average polishing room. E.P.R.

Evolution of the art of grinding. R. L. COTTERILL. *Abrasive Ind.*, 9 [9], 243–44 (1928). E.P.R.

Plan machine tool exposition. ANON. *Abrasive Ind.*, 9 [9], 244 (1928).—Dates have been set and a lease of a part of the extensive Cleveland Public auditorium obtained for the second National Machine Tool Builders' exposition Sept. 30 to Oct. 4, 1929. E.P.R.

Cutlery grinding methods in a midwestern plant. FRED B. JACOBS. *Abrasive Ind.*, 9 [9], 245–48 (1928).—With the gradual expansion of industry during the past half century the cutlery manufacturing business has developed along modern lines wherein drop-forge hammers have superseded the hand work, while manufactured abrasives have replaced the sandstone formerly used for grinding. The plant of the Henkel Clauss Co., Fremont, O., is described in detail. E.P.R.

Control of tool making costs increases output. G. A. PENNOCK. *Abrasive Ind.*, 9 [9], 249–52 (1928).—The purpose of the article is to discuss some of the means of speeding up the output on a class of work which is in a sense nonrepetitive, and therefore difficult to measure. Specifically, there is outlined briefly the problem at the Hawthorne works of the Western Electric Co., relative to the manufacture and repair of tools and to explain what is to be done there to get better measures of performance on this class of work, which is usually carried out on the straight-day-work plan. E.P.R.

Grinding of machine knives. W. E. WHITING. *Abrasive Ind.*, 9 [9], 252–53 (1928).—There are two types of wheels used for this work, both of which are manufactured alumina, the straight wheel and the cup wheel. The segment wheel is also being used for this work, but it is rather new on the market. The straight wheel ranges from about $3x^1/_2$ to $26x^1/_2$ inches. The cup wheels range from 6 to 18 inches in diameter. The straight produce a concave surface on the knives which is weaker than the flat surface, but is desirable on some knives as it gives a keener edge for finer finish on lumber. The amount of concave is governed by the diameter of the wheel. Grinding may be done either wet or dry. The wheels of larger diameter are used mostly on carbon steel and welded high speed steel knives. These wheels may be made by either the vitrified or silicate process. For dry grinding the silicate wheel seems to be the better as it is cooler cutting. For wet grinding the vitrified process wheel is best as it is more uniform, and grinding solutions do not affect the bond as they do on a silicate bonded wheel. E.P.R.

Grinding method reconditions large cylinders effectively. ANON. *Abrasive Ind.*, 9 [10], 263–66 (1928).—The importance of air pump efficiency is causing discussion regarding the best method to use to recondition the pump cylinders. In many cases the pumps, even after being reconditioned, fail to meet the tests required by government standards and must be taken apart and pistons and rings lapped in. Results of a careful investigation, made by the Micro Machine Co., on reconditioning methods, requirements, and efficiency are given. In the past the most commonly used method for reconditioning pumps was the boring operation, but the conditions which present difficulties to boring are in the form of thick walls, hard spots due to chills, and ribbing. Such conditions make for varying resistance to the cutting tool on the cylinder wall with the result that the finished cylinder is imperfect by being out of round and tapered, and the cylinder walls wavy. Grinding remedies these difficulties. When pumps or bushings are ground the resulting surface is very much superior to that obtained through boring. As the grinding wheel is composed of many tiny particles, it removes the necessary metal with a minimum pressure against the cylinder walls. Due to the light pressure of the wheel against the walls the grinding process is not

affected by the thick or thin walls, hard spots, etc., with the result that grinding will produce a straight round hole. The superior smoothness of a ground surface will not only allow a closer fit on the pistons and rings but will reduce wear to a minimum through the elimination of internal friction. By using a wide range grinder and extra equipment the machine may be used to grind holes ranging from $1^1/_8$ to 15 in. E.P.R.

Advance metal polishing theory. F. A. ZUCKER. *Abrasive Ind.*, 9 [10], 269 (1928). E.P.R.

Sharpening woodworking saws and planer knives. W. A. MCMILLAN. *Abrasive Ind.*, 9 [10], 270–71 (1928). E.P.R.

Plow parts fitted accurately by grinding. ANON. *Abrasive Ind.*, 9 [10], 275–76 (1928).—Plow grinding can be divided into three distinct operations: surfacing, fitting, and polishing. E.P.R.

Abrasive wheels replace sandstone. W. HAMILTON GORDON. *Abrasive Ind.*, 9 [10], 277–78 (1928).—The market for manufacturing abrasive wheels is increasing and likely to intensify its capacity for absorption. E.P.R.

Massive grinder supersedes planer. ANON. *Abrasive Ind.*, 9 [10], 278–79 (1928). —A grinding operation used daily at the U. S. Radiator Co., Detroit, proves that a large surface grinding machine can be used to advantage to perform work that has heretofore been done by the slower and more costly operation of planning. The work consists of finishing sections of boilers. E.P.R.

PATENTS

Grinding machine. WALDO J. GUILD AND FREDERICK H. GRIMSHAW. U. S. 1,684,485, Sept. 18, 1928. In a grinding machine, the combination with a grinding wheel, work-holding means, and means for reciprocating one part relative to the other, of a wheel dressing device, means for extending the amplitude of reciprocation to dress the wheel by the dressing device, and means causing the dressing device to operate only periodically, upon the completion of the grinding of a predetermined plurality of work pieces by the machine.

Grinding machine. WALDO J. GUILD AND LEWIS CLIFFORD KENYON. U. S. 1,684,486, Sept. 18, 1928. In an internal grinding machine, the combination with a grinding wheel, work-holding means, and means for reciprocating one part relative to the other, of a wheel dressing device, and automatic means for extending the amplitude of reciprocation a plurality of times during the operation on a single work-piece whereby to dress the wheel a plurality of times during the operation.

Grinding machine. RICHARD A. HEALD, CARLE J. HIGHBERG AND EDWARD M. TAYLOR. U. S. 1,684,487, Sept. 18, 1928. In a grinding machine, a plurality of wheel dressing devices, hydraulic means automatically brought into action to severally move the devices into operative position at different stages in the reduction of a work-piece, and mechanical means also automatically brought into action to reposition the devices.

Segmental grinding wheel. THURE LARSSON. U. S. 1,684,770, Sept. 18, 1928. A grinding wheel comprising a rotatable drum having a cylindrical surface, abrasive segments which have dove-tailed portions providing faces fitting on the drum and extensive angularly arranged plane clamping faces, a set of alternately arranged locating and clamping blocks on the drum positioned between adjacent pairs of segments, the blocks having extensive faces contacting with clamping faces of the segments, means for holding the locating blocks fixedly in position to locate the segments therebetween and means for adjusting the positions of the clamping blocks to draw the segments securely against the locating blocks and fasten them securely on the drum.

Grinding machine having balanced spindle. SOL EINSTEIN. U. S. 1,684,792, Sept. 18, 1928. A grinding machine comprising a bed provided with a horizontal guideway;

a head translatably supported on it; a spindle journaled in the head; a grinding wheel and a pulley spaced apart on the spindle; a belt-drive exercising a rearward pull on the pulley; and a feed-screw arranged substantially midway between the wheel and pulley and substantially in the horizontal and vertical planes of the guideway as to act as a fulcrum and balance the head against twisting under the pull of the belt and the pressure of the grinding wheel on its work.

Circular-grinding machine. WALTER STORCK. U. S. 1,685,757, Sept. 25, 1928. In a circular grinding machine or the like, a machine frame, a reciprocable grinding wheel spindle mounted therein, a lever pivotally mounted in the machine frame, means operatively connected to the spindle and engaging the lever for imparting oscillating movement thereto, and means transferring oscillating movement of the lever to the spindle, the means comprising adjustable mechanism on the shaft for regulating the extent of the movement imparted to the spindle.

Cylinder grinding machine. GEORGE N. SIMPSON. U. S. 1,686,181, Oct. 2, 1928. In a cylinder-grinding machine, means for supporting and rotating a cylinder; a grinding wheel shaft adapted to enter the cylinder; a housing for the grinding wheel shaft, the shaft projecting beyond the end of the housing and supported in a bearing carried by the end of the housing; a grinding wheel on the projecting forward end of the shaft; means for rotating the grinding wheel shaft; means for reciprocating the grinding wheel longitudinally in the cylinder; and means for holding the grinding wheel away from the bottom of the cylinder, comprising a horizontally arranged guard arm having one end attached to the housing and the other end adapted to bear against the inside of the wall of the cylinder to prevent the grinding wheel from resting on the bottom of the cylinder.

Grinding machine. RICHARD A. HEALD AND WALDO J. GUILD. U. S. 1,686,275, Oct. 2, 1928. In a grinding machine, a plurality of grinding wheels whose axes are parallel, workholding means adapted to hold work engageable at separate individual places by each of the grinding wheels, means for producing such an orbital movement of the workholder as to cause an equal individual orbital movement of each grinding wheel-engaging position of the work about its grinding wheel, and for varying the radius of the common orbit of the workholder and thereby equally varying each individual orbit, and a dressing tool for each grinding wheel, the tools being so arranged that the axes of all the individual orbits are equally spaced in the same direction each from the dressing tool for its grinding wheel whereby, due to the equal variation of radius of all the orbits, the relation of all the points of contact of the work with the grinding wheel to the points of engagement of the dressing tools with the grinding wheels will remain each equal to every other, regardless of such variation of radius of the orbit.

Dressing attachment for hob-grinding machines and method of dressing grinding wheels. JOHN EDGAR. U. S. 1,686,802, Oct. 9, 1928. The combination with means for rotatably supporting a grinding tool, of an attachment for dressing the tool, the attachment comprising a base, a base mounted upon the first base for longitudinal adjustment thereon, a templet carried by the second base, and a dressing tool carrier comprising an arm having a dressing tool thereon, the lower end of the arm being mounted on the second base to turn on an axis substantially coincident with the point of the dressing tool, the arm being adapted to slide along the templet to guide the dressing tool carried thereby in a predetermined path with respect to the peripheral surface of the grinding wheel.

Abrasive-supply tank. LOUIS D. PEIK. U. S. 1,686,877, Oct. 9, 1928. A sand-blast tank including an outlet in the lower portion thereof, a port in the wall of the tank, and a shield attached to the wall and surrounding the port, the shield being extended to overlie the outlet.

Abrasive article. RICHARD P. CARLTON. U. S. 1,686,898, Oct. 9, 1928. An abrasive element comprising a relatively rigid paper backing, a cloth backing adhesively secured thereto, and abrasive material adhesively secured to the cloth, the composite structure being sufficiently ductile to permit of distortion of a part without actual rupture and without material distortion of the entire backing.

Rubber-bonded abrasive article and method of making the same. DUANE E. WEBSTER. U. S. 1,687,410, Oct. 9, 1928. The improvement in the manufacture of rubber bonded abrasive articles comprising mixing rubber latex, a vulcanizing agent and an accelerator, and abrasive grains, coagulating the mixture thus obtained, and thereafter vulcanizing the coagulated mixture.

Manufacture of glass, sand, or flint paper, emery cloth, and like abrasives. CARL ADOLPHE KLEIN AND ROBERT SKIRVING BROWN. U. S. 1,687,453, Oct. 9, 1928. A process for the manufacture of waterproof sheet abrasive material consisting in waterproofing the base by passing it through a bath of linseed oil containing a small proportion of a suitable wax and kept at a temperature of at least 100°C; removing any surplus by means of pressure rollers also kept heated to 100°C or over; applying the adhesive consisting of a mixture of a drying oil with a synthetic resin also at a temperature of over 100°C; applying the abrasive material to the base thus prepared and baking at a temperature of over 100°C; and applying a second coating of adhesive and rebaking also at a temperature of over 100°C.

Glass, sand, or flint paper, emery cloth, or like abrasive. CARL ADOLPHE KLEIN AND ROBERT SKIRVING BROWN. U. S. 1,687,454, Oct. 9, 1928. A waterproof sheet abrasive material comprising a base, a waterproofing composition applied to such base as a preliminary treatment and consisting of linseed oil with a small proportion of paraffin wax, an adhesive composition subsequently applied and consisting of a drying oil with a gum, and an abrasive material.

Truing grinding wheels. G. J. SUTTON, P. NUCKEY AND R. J. SCOTT. Brit. 294,589, Sept. 19, 1928. A grinding wheel or like cutting tool carried by a slide movable on a machine bed by a screw is trued or formed to a required profile by means of a diamond or abrading tool carried on the short arm of a pantograph, the long arm carrying a tracer of contour corresponding to the tool which is moved over a pattern corresponding to the profile of the wheel but on an enlarged scale. The pattern is mounted on a slide movable by a screw to position the tool against the wheel. Movements of the slide are indicated by a gage having a pointer and actuated by movement of a slide which is coupled to the slide by a lever having arms in the same ratio as that of the arms of the pantograph; the pointer thus indicates when the work mounted between the centers is to size, irrespective of the reduction diameter of the wheel.

Grinding balls, etc. CINCINNATI GRINDERS, INC. Brit. 294,594, Sept. 19, 1928. A centerless machine for grinding spherical articles, *e.g.*, balls for bearings, consists of a grinding wheel having therein a series of annular grooves and a grooved regulating-wheel, the work being supported between the wheels on a rest adjustable as to height by inclined surfaces. The balls are fed automatically to the machine, and are moved from one groove to another at intervals, the movement being timed to take place as the regulating wheel is retracted from, and again advanced up to the grinding wheel. These movements are brought about by a cam which engages a toggle to move the slide carrying the regulating wheel, and also has a projection which, through rack gearing, oscillates a rock shaft and this shaft, through linkage oscillates a shaft journaled in a housing. In the housing, on sprockets is mounted an endless chain carrying grooved work-feeding blades which engage the balls and move them from groove to groove, the intermittent movement of the blades being effected by a pawl slidable in the housing and engaging rack teeth on the blades; the pawl is moved in one direction by a lever on the shaft, and in the other direction, to move the work, by a spring. When the work is to be

moved into each groove, or every other groove, it is fed in a continuous stream down a tube into the grooves in the blades, oversize pieces being ejected automatically by engagement with a spring finger which moves to allow the work to pass into a discharge passage. When the work pieces are to be advanced more than one groove at a time, they are fed down three guide tubes, being released therefrom by the lifting of a detent, which is normally held down by a spring plunger, and is lifted by a notched disk mounted on the arm and rotated intermittently by a pawl which engages a ratchet on the notched disk.

Gear-cutting. LEES-BRADNER CO. Brit. 294,620, Sept. 19, 1928. In a method of producing gear teeth by rolling a gear blank relatively to a rotating tool, the generating movements may be modified by imparting supplemental motions to the blank or tool to produce predetermined modification of the theoretical involute tooth profile.

Grinding cutter blades. BOLINDERS MEKANISKA VERKSTADS AKTIEBOLAG. Brit. 295,030, Sept. 26, 1928. In a machine for grinding cutters, *e.g.*, the thin blade cutters of planing machines, the cutter-holder consists of a shaft upon which is rotatable and slidable, by means of handles a support having projecting arms and rotatably carrying a shaft to which an arm is secured by means of a screw. The cutter blade is clamped against the support by springs carried by the shaft, the springs being moved to clamp the blade by a screw acting on the lever. The back edge of the cutter rests against an abutment bar which is moved parallel to itself, to position the cutter against a gage by pins carried by crank disks rotated together, through worm gearing by hand wheels on the spindles of the disks. In operation the holder is turned over on the shaft until the arms rest on a bar, and is then reciprocated on the shaft with the cutter edge in contact with a cup-shaped grinding wheel; on completion of the grinding, the support is turned back until the arm rests under the bar and the screw is loosened, permitting the support to fall away from the blade for removal thereof and insertion of another blade. The gage is slidable in a sleeve; the shaft of the grinding wheel is hollow for the supply of water, which is spread over the wheel by centrifugal force.

Grinding lathe tools, etc. H. A. DUDGEON. Brit. 295,169, Sept. 26, 1928. A machine for grinding lathe tools, drills, cutters, etc., consists of a head rotatably mounted in a hollow casing and carrying in bosses and bearings a spindle to which are secured grinding wheels and which has thereon a pulley. In order to allow the spindle to be turned 360° about the vertical axis of the head without the driving belt running off the pulleys, the spindle is set with its axis to one side of the vertical axis by an amount approximately equal to the radius of the pulley, and the machine is so set that the vertical axis coincides with the center of the face of the overhead driving-pulley on its downward running side. The casing is rotatably mounted in a column; the head and casing may be locked in adjusted positions by screws engaging grooves. In order to regulate the level of water in the casing a vertically adjustable overflow pipe is provided, leading to a funnel in the column.

Grinding wheels. NORTON CO. Brit. 295,292, Oct. 3, 1928. Grinding wheels are made from abrasive grains (crystalline alumina or silicon carbide) and a vitrified ceramic bond having the same coefficient of expansion as the grains at temperatures below the annealing range. A bond mixture suitable for alumina grains consists of oxides of silicon (55.0), aluminum (11.4), iron (4.3), magnesium (2.8), calcium (5.9), sodium (6.0), potassium (2.6), titanium (0.7), and boron (11.3). This differs from a known bond mixture, which is quoted, principally in the presence of boron oxide, in the greater proportion of sodium oxide, and in the less proportion of aluminium oxide. 1 lb. of grains and 1 oz. of this bond mixture are wetted, shaped, fired to about 1125° C (which temperature is high enough to vitrify the bond, but not high enough to take much slag out of the grains into the bond, or to cause swelling by evolution of gas, *e.g.*, due to decomposition of ferric oxide), cooled rapidly to 800° C (to prevent formation

of crystals of feldspar), and then annealed by cooling slowly to below the temperature (about 600° C) at which the bond is solid.

Art

International Ceramic Exhibition. CHARLES R. RICHARDS. *Creative Art*, **3** [4], xlii–xlvii (1928).—Pieces by foremost craftsmen of France, England, Denmark, Germany, Holland, Austria and Czechoslovakia are described and illustrated. Delaherche, the French pioneer in modern ceramics, is followed by Decoeur, Lenoble, and Lachenal. From Copenhagen, Bing, Grondahl, and Royal Porecelain manufactury stand unrivaled for artistic quality. Jais Nielsen, Hans Hansen, and Axel Soerensen show fish of Japanese simplicity. S. Fox Strangways and Mildred Lockyer represent English tile and potteries, while W. B. Dalton and Constance E. Wade express themselves in stoneware. Germany, on the other hand, is producing very little high fire decorative ware, but State potters are beginning to turn in this direction. Joseph Wackerle shows an interesting majolica garden figure; Max Lauger, white and blue faience; Ludwig Konig, tile in strong blue, red, and black. Paul Dresler is poorly represented. Interesting material is shown from the Burg Giebichenstein. Viennese pottery is ably represented by talented modern artists, among whom are Vally Wieselthier, Susi Singer, Herta Bucher, and Dina Kuhn. Contrast of the American section is most interesting. Rookwood and Cowan are not represented. Among those showing are Adelaide Robineau, Charles Binns, Leon Volkmar, Frank B. Kelley, and Inwood Pottery. The outstanding feature in the American section is the varied and important tile and terra cotta for architectural purposes. American Encaustic Tile Co., is represented by Aztec design on silver and gold background, executed by Agustin Lazo. M.G.W.

Modern German china and faience. MAX SCHEFOLD. *Creative Art*, **3** [4], 258–63 (1928).—Art is once more creeping into everyday life in two distinct paths, decoration and form. The form and pattern must be modified to meet the present needs. Artists must produce artistic models suitable for quantity production. Stoneware is practically on the same basis as china, although, owing to the craft workshops' production of more personal ceramic designs, is not taking its place. All formalistic fancy is avoided. Illustrated. M.G.W.

Allied arts and craftsmanship. ANON. *Arch. Rec.*, **64** [2], 165 (1928).—Illustration of vase in Copenhagen porcelain, by Jans Nielson, potter. E.B.H.

Prehistoric man of Rio Puerco. THOR WARNER. *Art and Arch.*, **26** [1&2], 44–50 (1928).—In the valley of the Rio Puerco, N. M., were found the remnants of a once prosperous city devoted to pottery manufacture. The subsoil was a clay suitable for pottery making and the many fragments indicate that this was one of the main ancient potteries of this part of New Mexico. The emblems and designs on the broken bits indicate no small art and skill and many of the colors, dark brown, deep green, red, pink, yellow, and jet black remain clear. Bands varying from fine lines to $^1/_4$ in. streaks are placed both vertically and horizontally. Dots of contrasting colors or checker-board patterns were used. The surface bears a veneer of a finer clay or smooth glazing material. E.B.H.

The dazzling charm of painted glass. PIERRE DUTEL. *Arts and Dec.*, **29** [4], 48–49 (1928).—A new old fashion of the moment is painted mirror glass used as panels in rooms, especially where a feeling of space is desired. It dates back to Versailles and the time of Marie Antoinette. The process of glass painting is slow and painstaking due to the fact that the design is painted on backward. After drying thoroughly it is backed with gypsum paint to protect it when the glass is silvered. E.B.H.

Spanish porcelains of living beauty. DOUGLAS NORRIS. *Arts and Dec.*, **29** [5], 52 (1928).—With the recent revival of arts and crafts in Spain come evidences of a new school of ceramic artists in that country. The old facility has been regained, chiefly

in the figures by the artist Peyro, whose power is displayed in the delicacy of the features and his use of the pigments. His medium is soft clay shaped to proportions and then sculptured. The glaze is so carefully applied as to afford a curious reality to the shadings of the colors used, which are brilliant yet soft hued. Peyro porcelains also include decorative vases and domestic wares. Inspiration has come from the famous Buen Retiro factory of Charles III which in turn was founded on the traditions of the Capo di Monte in Naples. E.B.H.

Unique doorways with matching lighting fixtures. ANON. *Arts and Dec.*, **29** [6], 50–51 (1928).—Illustrations of doorways combining tile or plastic effects with appropriate lighting fixtures. E.B.H.

Bristol and Liverpool delft ware. ANON. *Int. Stud.*, **90** [374], 29–32 (1928).—The distinctive characteristic of Bristol delft is that its enamel is usually a greenish blue, while that of Liverpool is a more decided blue. Bristol ware was often treated with a pure white glaze over the tin enamel surface. The most representative collection of early English delft is in the Pennsylvania Museum at Philadelphia. From Bristol came many election plates naming the candidates of the year. Noteworthy on some Liverpool is the famous blue developed by Seth Pennington often used in large scenes entirely in that shade. Printed designs soon largely supplanted the hand painting and there was artistic excellence in the tiles produced in Bristol and Liverpool during the second half of the 18th Century. At first the printing was restricted to red and black. The Bristol potters prepared their clay carefully and were capable of delicate throwing. E.B.H.

The Parisian Rivals of Sèvres. HAROLD DONALDSON EBERLEIN. *Int. Stud.*, **91** [376], 24–29 (1928).—The monopoly granted to the Sèvres porcelain works when it became Crown property in 1759 only served to stimulate other factories to evasions of the edict and to greater heights of perfection, though simulating Sèvres in every particular. Many of the products fully equalled Sèvres. The result was the golden age of porcelain making in France. The rivals include Vincennes; the Comte d'Artois at Vaux; the Fabrique de la Courtille; de la rue de Reuilly; de Monsieur at Clignan court; de la Reine, rue Thiroux; du Duc d'Augorilême, rue de Bondy; de la rue Popincourt; and du Duc d'Orleans. Their works would prove no less satisfactory than Sèvres to collectors, though a less canvassed field. E.B.H.

Pottery making. E. W. GIFFORD. *Nature*, **122**, 417 (1928); Univ. of Calif., *Publ. Amer. Arch. and Ethn.*, **23**, 8 (1928).—Among the southwestern American Indians the wooden paddle and pottery stone or anvil are much used in making pottery, the paddle being used to pat the outside and the mushroom-shaped anvil to form the inside. The method of coiling with the unaided hand is also used. C.R.A.

Tinting strength of pigments. H. D. BRUCE. Bur. Stand., *Jour. Research*, **1** [2], 125–49 (1928).—The tinting strength of pigments is discussed. It is not primarily proposed to offer a new method for estimating and expressing tinting strength, but rather to aid in clarifying ideas on the subject, so that when the science of colorimetries has been further advanced a rational means for appraising this valuable property may be the more easily developed. A distinction between the tinting strength of whites and blacks is drawn. New names for three differentiated factors involved in tinting are offered, *i.e.*, chromatic, darkening, and brightening strengths. A method for treating these properties photometrically or spectrophotometrically and of indicating their relative magnitudes by numerical indices is suggested. Tabular and graphical data are presented. In connection with and incidental to the subject of tinting, certain empirical formulas have been developed in the argument which may be used for computing the proper mixture of white pigment with another color in order to obtain a tint of some desired brightness or colorimetric purity. The procedure employed in this work for specifying color in the monochromatic terms of dominant wave length, purity, and brightness is set forth with concise explanation in an appendix. R.A.H.

Preparation of liquid bright and burnished gold. F. CHEMNITIUS. *Sprechsaal*, **60** [11], 182–84 (1927).—The complicated constitution of these preparations in the form of terpenes is discussed. Liquid bright gold is applied to the ware and fired. It results without further effort in a bright shiny gold. The burnished gold is applied as an oxide in suspension which after firing must be polished in order to obtain the proper finish. A complete description of procedure to follow in the small scale preparation of the two materials is included. Each step leading to the preparation of the compounds is clearly outlined. R.A.H.

History of glass. AARON MARC STEIN. *Amer. Glass Rev.*, **47** [47], 15–16 (1928).—History and development of glass from the day of Egyptian craftsmen is vividly portrayed. S. describes the types, uses, and decorations of the glass vessels of the early days and tells of the advance and decline of their development through the ages. E.P.R.

Decorating dinnerware. W. H. L. ANDERSON. *Crockery and Glass Jour.*, **106** [13], 31 (1928).—Pottery is decorated in many ways, according to its nature. The most outstanding methods are printing, decalcomania, hand painting, applying gold, and encrusting with gold. Decorations may be applied to the article before or after glazing. In underglazing the design is placed on the biscuit, the article is covered with glaze and fired for the second time. Not all colors can be used in this style of decoration. The most popular method of present day use is the decalcomania transfer and lines of color or gold. The patterns are prepared by a company making a specialty of their manufacture. The design is printed on large sheets of very thin tissue. The colors used for this printing are the various metallic oxides such as cobalt, chrome, etc. The lining is done by means of a wheel and brush. The ware is centered on a small wheel, one piece at a time, and a brush full of color is held at the desired place as the wheel is slowly rotated. The decorating kilns are small and of the muffle type. The ware is placed on racks on the shelves. The maximum temperature reached is about 1475°F. Gold is applied to china by using a small rubber stamp or by means of a brush. What constitutes good dinnerware and the care of dinnerware are discussed briefly. E.P.R.

French ceramic products in America. ANON. *Ceram. Ind.*, **11** [4], 362–63 (1928).—At Lord and Taylor's in New York City there is an attractive display of ceramic ware from the modern French ceramists including such well-known artists as Lenoble and Decouer. There are remarkable examples of the Renaissance in decorative glass which is now sweeping France. An interesting representative of glassware is the *pate de verre* decorative glassware of François Decorchemont. This ware is made by filling plaster molds with glass powder and firing to a heat just short of vitrification. F.P.H.

A visit to René Lalique. ANON. *Keram. Rund.*, **36**, 228–30 (1928).—Descriptions and illustrations are given of Lalique's artistic productions in glassware. H.I.

Exhibition of the Royal Copenhagen porcelain factory in the old Berlin Industrial Arts Museum. J. GRELL. *Keram. Rund.*, **36**, 248 (1928).—A brief history of the Copenhagen porcelain works and of the types of products is given. The work of the present Copenhagen artists is described and the paper is illustrated with samples of their work. H.I.

Ancient wall plaques from Ulm. MAX SCHEFOLD. *Keram. Rund.*, **36**, 351–55 (1928).—Ceramic wall plaques from Ulm dating from the 13th to the 15th Centuries are described. These were in all cases unglazed and the designs were either incised in the raw pressed clay with a sharp instrument or were pressed in with a stamp. The plaques were used as decorations on cloister walls and the walls of private homes. The earliest designs were of centaurs and other fabulous beasts. Later mounted knights, geometrical figures, and conventional oak leaves were motifs. Illustrated. H.I.

Danish porcelain. ANON. *Keram. Rund.*, **36**, 413–16 (1928).—Historical sketch of the Danish firm of Bing and Gröndahl describing the work and motifs of artists employed by them. Illustrated. H.I.

Modern Viennese ceramics: a visit to Franz Iskra. FRANZ SCHARETZER. *Keram. Rund.*, **36,** 432–34 (1928).—Illustrations of the work of this ceramist and artist (mostly ceramic stoves) are given. H.I.

Celtic remains at Guntramsdorf, Austria. F. C. FUERST. *Illust. London News*, **173,** 390–91 (1928).—The graves recently discovered near Vienna belong to the La-Tène epoch, which is the second Celtic Age of Iron. Clay vessels (illustrated) with food and drink were buried with the dead warriors. H.H.S.

Clay mascots in India. W. J. HATCH. *Illust. London News*, **173,** 420 (1928).—The god Iyenar is a protector of fields and crops. He is seen all over southern India, and about his temple are found large clay horses, and sometimes clay elephants, upon which he rides his rounds by night. H.H.S.

Relics at Skara Brae, Orkney Islands. V. G. CHILDE. *Illust. London News*, **173,** 448–49 (1928).—Excavations of storm-revealed masonry present an enigma as to the date of the settlement. A runic inscription which points to a date not earlier than 600 A.D. conflicts with Stone Age relics. The pottery found is so badly baked that it falls to pieces, but the many fragments are decorated with relief moldings, and there is a little bowl with crinkled rim which displays real artistic feeling. C. is professor of archæology at the University of Edinburgh. H.H.S.

Discoveries at Vouni in Cyprus. EINAR GJERSTAD. *Illust. London News*, **173,** 498–500 (1928).—The swedish expedition in Cyprus, of which G. is head, has uncovered a palace at Vouni rich in sculpture of terra cotta, limestone, and bronze. The finds are unparalleled in Greek archæology, and it is claimed that Cyprus rivals Crete as an archæological treasure-island. Of the 16 photographs of statues and statuettes, one shows a cult bull with a curious "plaid" pattern on its body. H.H.S.

Mexican pottery. E. NOGUERA. *Science Supp.*, **68,** 10 (Sept. 1928).—N. has made a statistical study of 6000 pieces of pottery in Mexican museums, including Zapotec, Mixtec, Tarascan, Toltec, and Aztec ware. Zapotec pottery uses the human figure as decorative motive, thus suggesting that the race had left behind the animal totem stage of culture. In the other races geometrical motives are more important than human, and human than animal, while plant motives are rare, but many of their geometrical symbols have undoubtedly evolved from a natural form such as conventionalized snakes. H.H.S.

Sultan of Turkey's collection at Stamboul. ANON. *Times*, Sept. 1 (1928).—A collection of priceless china that belonged to the Sultans of Turkey has been placed on exhibition at the Top Kapou, Stamboul, which was formerly the Sultan's palace. Illustrated is a big Sèvres vase from the collection. H.H.S.

Graphic representation of colors. S. RÖSCH. *Physik. Z.*, **29,** 83–91 (1928).—Every color can be defined by means of its "relative brightness," the relative width of its spectrum, and the mean wave length. An apparatus is described, whereby any color may be compared by synthesis in terms of these 3 coördinates. (*C. A.*)

PATENTS

Goblets. EDGAR M. BOTTOME. U. S. 76,372–3, Sept. 25, 1928. Ornamental designs for goblets.

Pitcher or similar article. ROBERT E. MCELDOWNEY. U. S. 76,409, Sept. 25, 1928. The ornamental design for a pitcher or similar article.

Dish or similar article. JOSEPH S. RICHARDSON. U. S. 76,420, Sept. 25, 1928. The ornamental design for a dish or similar article.

Plate. EMIL L. SCHNEPF. U. S. 76,426, Sept. 25, 1928. The ornamental design for a plate.

Plate or similar article. WILLIAM H. TAMS. U. S. 76,433, Sept. 25, 1928. The ornamental design for a plate or similar article.

Plates. EDGAR M. BOTTOME. U. S. 76,454–5, Oct. 2, 1928. Ornamental designs for plates.

Dish or similar article. WILLIAM P. GRAHAM. U. S. 76,536–7, Oct. 9, 1928. Ornamental designs for dishes or similar articles.

Glass jug. SYLVESTER A. LANGENBAKER. U. S. 76,545, Oct. 9, 1928. Ornamental design for a glass jug.

Plate or similar article. HEINRICH RAMPFEL. U. S. 76,550 Oct. 9, 1928. The ornamental design for a plate or similar article.

Plate or similar article. FRANK A. SEBRING. U. S. 76,557 Oct. 9, 1928. The ornamental design for a plate or similar article.

Plates or similar articles. URASABURO TOMITA. U. S. 76,567 to 76,590 (24 patents) Oct. 9, 1928.

Printing plates; ornamenting articles. J. R. GUÉRARD. Brit. 294,987, Sept. 26, 1928. In preparing printing plates or decorating articles, a support is provided with a coating of varnish which is permeable to water, sufficiently friable to enable a design to be cut therein by a tool to expose the support, but convertible by moderate heat into a hard and impermeable layer without melting. A suitable varnish is prepared by adding a solution of an ether or ester of cellulose in acetone to a solution of one or more gum resins in an alcohol-ether mixture. The coating may be applied to the printing plate itself or to a separate support. A printing plate prepared with the design, may be etched to obtain the design in intaglio or may be placed in an electrolytic bath to form a relief design. A planographic plate may be prepared by providing the plate with an ink-repellent coating before applying the varnish; the design is then traced to expose the bare metal, ink is applied to the design, and the varnish removed. An alternative method of treating the prepared plate is to coat it with a solution of bitumen in benzine and, after drying, treating it with alcohol so as to disintegrate the varnish and allow it to be removed from the plate together with the superposed bitumen. A plate having the design in bitumen is thus obtained and this plate may be converted into a relief plate by etching or into an intaglio plate by providing the exposed portions with an electrolytic deposit, removing the bitumen, and etching the plate with a reagent which does not affect the deposited metal. A negative for the preparation of a printing plate photographically may be made by applying the varnish coating to a sheet of celluloid or other transparent material provided with a coating of a dark material, and then tracing the design to expose the celluloid. The plate to form the printing plate is provided with a coating of the varnish and sensitized by silver or iron salts. After exposure beneath the negative prepared as described above, the plate is developed and dried and the design traced over with a sharp tool to produce an engraved plate. In any of the methods of procedure described the support may be provided with a dark coating before receiving the varnish to facilitate tracing the design. If the support is of zinc, aluminium, or copper, this coating may consist of brown oxide of manganese and may be formed by dipping the support into a bath of potassium permanganate and hydrochloric acid. The coating may be removed by sodium sulphite when necessary.

Cement, Lime, and Plaster

Workability of Portland cement pastes. ANON. Bur. Stand., *Tech. News Bull.*, No. 137, p. 128 (1928).—A discussion of the results obtained from a method of determining the workability of cement pastes with the MacMichael viscometer. R.A.H.

Tensile strength of mortar in brickwork. ANON. Bur. Stand., *Tech. News Bull.*, No. 137, pp. 128–29 (1928).—A series of tests of the adhesion of mortar to sand-lime brick has furnished an opportunity for comparing the tensile strength of the mortar in the brick with the strength of the same mortar in the form of standard briquets.

The results reported were obtained with a 1:1:6 cement lime mortar in which various amounts of diatomaceous earth had been substituted for equal amounts of lime. A table is included comparing the values obtained using from 0 to 100% diatomaceous earth in increasing increments of 10%. Values are given as obtained from specimens taken near the edge of the brick, from the interior and from briquets. Values range from 27 to 82 lbs. per sq. in. R.A.H.

The fuel question in the cement industry. O. V. MARCH. *Chem. and Ind.*, **47,** 995 (1928).—The controversy over wet and dry methods of making Portland cement in rotary kilns has benefited the industry by promoting the efficient use of coal, which represents half the prime cost of cement. The use of powdered fuel and the raising of steam in boilers heated by waste heat from the high-temperature exit gases have doubled kiln efficiency. As the demand for better cement grows, more and more power will be required, especially for finer grinding. M. estimates the world production of cement to be 59 million tons per annum, and calculates that it should be possible to save 5 out of the 24¼ million tons of fuel (coal, coke, lignite, peat, and oil) now being used. H.H.S.

Cement-water ratios in concrete. ANON. *Nat. Phys. Lab.* (1928); *Engineering*, **126,** 36 (1928).—Using a 1:2:4 mixture with varying percentages of water, it was found that 53% of water (by weight of cement) gave the best results after 6 months, and 61% water after 12 months. H.H.S.

Ciment fondu. ANON. *Nat. Phys. Lab.* (1928); *Engineering*, **126,** 36 (1928).—The doubts which have been expressed as to the use of *ciment fondu* in hot climates, are not confirmed by experiment except perhaps for abnormally high structural stresses. Mixtures (4:2:1) were gaged at temperatures ranging from 65 to 125°F. As the temperature of molding was raised, the strength of cement fell off from 7000 lbs. per sq. in. at 65°F to 4000 lbs. at 125°F, and the increase in strength up to 28 days was very small, but the final strength after 180 days was well up to the figure of ordinary Portland cement. H.H.S.

Concrete deterioration in sea-water. E. A. CULLEN. *Engineering*, **126,** 112–13 (1928).—Eight reinforced-concrete test blocks have been re-examined after 9 years exposure under a wharf in the harbor at Brisbane, Australia. The apparent deterioration described in 1923 had only increased very slightly, and all cracks which had occurred since 1924 were on the upper face of the blocks where they had been exposed to sun and atmosphere when uncovered by the tide. At other wharves, however, it appeared that although visible deterioration does not seem to proceed during the third to the sixth years, the steel continues to rust, and its deterioration seemed continuous. H.H.S.

Effect of curing on apparent free lime content of Portland cement. ARTHUR J. POOL. *Rock Prod.*, **31** [19], 70 (1928).—According to Lerch and Bogue the ammonium acetate test for uncombined lime in Portland cement reacts positively in the presence of $Ca(OH)_2$, as with CaO, but they consider the presence of more than traces of $Ca(OH)_2$ in fresh cement as generally improbable, and that any $Ca(OH)_2$ formed by the hydrolysis of the silicates by atmospheric humidity or by a spray of water on the clinker probably becomes carbonated very rapidly, forming $CaCO_3$, which reacts negatively in the test. During the course of some recent investigations it was found desirable to determine the uncombined lime in several samples of Portland cement. Determinations of free lime were made by the ammonium acetate method on the freshly ground cements, and on the same cements after curing for one, three, and seven days in cloth sacks in air of the laboratory. The results obtained appear to indicate that a comparatively large amount of $Ca(OH)_2$ may exist in fresh cement, and that subsequent carbonation may not proceed as rapidly as might be expected. The effects of curing on apparent free lime content of Portland cement are as follows:

	Uncombined CaO (%) Cement					
Age at test	A	B	C	D	E	F
Fresh	0,41	0.76	0.53	0.43	0.98	1.23
1 day	0.88	1.16	1.13	0.88	1.35	0.41
3 days	0.41	1.20	0.69	Tr.	0.47	0.50
7 days	Tr.	0.88	0.53	0.85	0.94	Tr.

It will be observed that the apparent free lime content was in general higher after the cements had cured for one day than it was in the fresh samples, and that in some of the cements the apparent free lime content was higher after three and even seven days' curing. This increase may be attributed to partial hydrolysis of the silicates by atmospheric humidity. F.P.H.

An American pozzuolana and its effect on Portland cement concrete. E. Lee Heindenreich. *Rock Prod.*, **31** [20], 39–44 (1928).—H. describes the use of pumicite, a volcanic ash found in Kansas, and how it is being exploited. F.P.H.

Pozzuolanas. Anon. *Rock Prod.*, **31** [20], 56–58 (1928).—The history of building shows that certain types of lime mortar, more particularly those used by the Romans in some of their large public works, have proved to possess extraordinary hardness and durability, as well as a degree of impermeability to water that compares well with that of first-class Portland cement mortar. In many cases the strength and adhesive power of the mortar is such that, when a piece is broken across, the particles of aggregate will themselves fracture rather than part from the mortar. A substance is said to be pozzuolanic when, while not necessarily cementitious by itself, it possesses constituents which will combine with hydrated lime at ordinary temperatures in the presence of moisture to form stable insoluble compounds of cementitious value. When mixed with lime mortar in addition to, or in partial substitution for, sand, it will impart hydraulic properties and greater strength. Pozzuolanas may be classified as follows: (*a*) Natural Pozzuolanas: Italian pozzuolanas; Santorin earth (Greek); trass (Rhine district and Bavaria); volanic ash deposits in southeastern France, Azores, Canaries, Japan; diatomaceous earth. (*b*) Artificial pozzuolanas: granulated blast-furnace slag; pounded brick and tile (certain varieties only), fired clay (Indian "Surkhi"), furnace clinker, "Si-Stoff" (residues from alum manufacture). (*c*) Dual Type Pozzuolana: Gaize. F.P.H.

Natural cement of Vassy. G. Bidaut de L'lsle. *Rock. Prod*, **31** [20], 63–64 (1928).—The rock which yields the Vassy natural cement is slightly bituminous and does not weather when exposed to air or cold; it is of a bluish gray color and shows a fine texture. When calcined, it loses 40% of its weight and becomes brownish yellow. Its chemical composition before and after calcination has given the following results in analyses made at the Materials Testing Laboratory of Paris:

Before calcination	%	After calcination	%
Silica	19.4	Silica	20.5
Alumina	5.9	Fine sand	3.3
Ferric oxide	3.0	Alumina	9.3
Calcium carbonate	63.7	Ferric oxide	5.5
Residue	8.0	Lime	50.0
		Magnesia	0.3
		SO_3	3.5
		Residue	6.7
	100.0		100.0

This chemical composition varies but little in the different quarries. One can, therefore, consider the Vassy cement as one of absolutely uniform chemical composition. It was this uniformity which brought about its success and permitted government as well as private contractors to class it among first quality products suitable for execution of important construction work. The Vassy cement is a hydraulic cement; under

the action of water it forms a double silicate of alumina and lime, which upon hydration rapidly yields a product of exceptional hardness. Used as mortar, it sets in air or under water, and acquires (cured dry and moist) a constantly increasing strength. After a few days of use it possesses properties of strength and adherence which can be obtained with the best hydraulic limes only after several years. F.P.H.

Literature on setting and hardening in Portland cement. R. H. BOGUE. *Rock Prod.*, **31** [20], 65–68 (1928).—It is generally conceded that the alumina-containing compounds present in cements constitute the one important group of substances upon which the rate of set depends. Some authors regard these as solid solutions of one type or another, some as distinct compounds. The most general opinion is that the alumina of cement clinker is in the form of tricalcium aluminate, but this is not an issue in the present case. It is agreed also that the alumina compounds or solid solutions (calcium aluminate) combine with water with great avidity, and that it is this hydration which causes the initial set. Consequently, the amount of calcium aluminate present, and the rate with which it hydrates, determines the rapidity of set. The amount of calcium aluminate in the clinker varies, but in manufacturing technology it is inexpedient to reduce the alumina content of the mixture to a point where slow set will result. It has been found, however, that the introduction of certain materials, notably some form of calcium sulphate, does materially modify the rate of set. Most authors have recognized that the action of the calcium sulphate must in some manner be dependent on an influence which it exerts on the rate of hydration of the calcium aluminate. The mechanism by which the calcium sulphate determines the hydration of the calcium aluminate has received various explanations. Chief among these may be mentioned the following: (1) the solubility of the aluminate is decreased in the presence of calcium salts, hence hydration is retarded; (2) the dissolved aluminate combines with calcium sulphate to form crystalline calcium sulpho-aluminate, preventing the normal hydration of the calcium aluminate; (3) rapid set, induced by alkali carbonates, is eliminated by neutralizing with calcium sulphate; (4) the set is caused by precipitation of colloidal silicate, induced by ions, especially, trivalent aluminate ions; calcium sulphate keeps the ion concentration too low to function as above by precipitation of calcium sulpho-aluminate; (5) the set is caused by precipitation of crystalline substances. Calcium sulphate retards the set by checking crystal formation and aiding in colloid formation. For previous abstracts see *Ceram. Abs.*, **7** [10], 662; [11], 742 (1928). F.P.H.

Electrical method for measuring the setting time of Portland cement. Y. SHIMIZU. Tohoku Imp. Univ., *Sci. Rept.*, **17**, 85–92 (1928); *Rock Prod.*, **31** [20], 84 (1928); for abstract see *Ceram. Abs.*, **7** [10], 664 (1928). F.P.H.

Stehmann process in the rotary kiln. KARL ANTON GOSLICH. *Tonind. Ztg.*, **52**, 421–23 (1928); *Rock Prod.*, **31** [19], 98 (1928).—The rotary kiln receives about twice the amount of air in the sintering zone as that received by the automatic shaft kiln. This large quantity of excess air must be heated to sintering temperature with large additional quantities of fuel in order to prevent a drop in temperature in the kiln. Stehmann selected two ways to improve the heat balance: (1) heating the minimum quantity of air and thus filling the space preceding the sintering zone, (2) reducing the suction and limiting necessarily the quantity of air to a minimum. A required condition in this connection is air-tight discharge of clinker from the cooler. The kiln committee of the Association of German Portland Cement Mfrs. conducted tests of the Stehmann process and found a reduction in fuel consumption of 14.8%; however, a simultaneous reduction in output was established, due to faulty operation. Stehmann proceeded as follows: he built a stationary cooler under the discharge end of the kiln and made it air-tight at the clinker discharge. As the shaft cooler has lately been replaced by the cooling drum, the latter was adopted by sealing both ends and making the discharge air-tight. The air required for combustion is blown through the cooler. Agitators

are provided to bring the air into intimate contact with the clinker. Although the shaft cooler required an additional supply of power of 30.7 H.P., no additional power is consumed by a kiln with cylindrical cooler. Surface cooling is considerably more effective than cooling in the shaft. Clinker leaves the drum at temperatures below 200°C. A fixed quantity of air is established for a certain capacity and certain charge and is kept constant by strict control. A rationally selected and uniform proportion of the raw mix, the charge and the air is thus maintained in the sintering zone. With proper operation, the operator should watch the CO_2 and CO meters, as they indicate the ratio of coal to air. A drop in stack gas temperature indicates a larger supply wave of material moving through the kiln, so that stronger firing is required temporarily. These improvements in operation have resulted in a fuel reduction of 23–26% for the wet process without having their initial disadvantages. The power consumption remains the same and the clinker leaves the cooler at about 180°C. The motto "shorter sintering, quick cooling" has been realized by this process. The quality of the clinker presents no doubts. Thorough preheating of the charge permits the successful use of coal varieties low in gas. F.P.H.

Identification of blast furnace slag in cements. H. W. SOUELL. *Zement*, **17**, 437–43 (1928); *Rock Prod.*, **31** [19], 98 (1928).—Hydraulic slags when heated with a solution of lead acetate, acidify with acetic acid and acquire a characteristic brown or black color. The phenomenon is easily observed by examining the granular particles under a microscope. Clinker from the 15 cements examined in no case colored the same. This makes it possible to establish the presence of slag additions in cements by means of the lead acetate treatment. The method is qualitative and would be of practical value in the discovery of adulterations. F.P.H.

High test cement hardening in ice water. H. VIERHELLER. *Zement*, **17** [23], 892 (1928); *Rock Prod.*, **31** [20], 84 (1928).—In connection with the investigation of H. Kühl (*Zement*, **16**, 31 (1927)) in regard to the behavior of Portland and alumina cements when deposited in ice water, V. has conducted experiments with alumina cement and found that this can be used for concrete even at the lowest temperatures. With fused alumina cement there does not appear, in the mortar itself and not even in the plastic state, a noteworthy retardation of the setting process because of low temperature. The mass of concrete has therefore no time to cool and it is warmed as soon as setting has started from the inside in such a manner that the hydration can proceed unretarded. Whereas high-test Portland cement shows, after 3 days of deposit in ice water, a tensile strength of only 122.3 lb. per sq. in. and a compressive strength of only 1001 lb. per sq. in., the fused alumina cement had after 2 days of deposit in ice water a tensile strength of 310 lb. per sq. in. and a compressive strength of 5874 lb. per sq. in. F.P.H.

Lime and its manufacture. ANON. *Eng. and Min. Jour.*, **125** [19], 768–73 (1928).—The following items are discussed in detail: composition of commercial lime; advantages of hydrated lime; mining, sorting, and loading limestone; size of kilns; linings; operating rotary kilns; manufacture of hydrated lime. A table gives in complete detail the variations in kiln design. Tables also give the dimensions of casings and the materials used in lining kilns. Sketches illustrate the round kiln with shaft drawn in, square kiln with straight shaft, round kiln with straight shaft, round kiln with flaring shaft, and round kiln with distorted conical shaft. Operation of the "following" process and of the "sticking" process is illustrated. A.J.M.

Portland cement in March 1928. ANON. *Iron Age*, **121** [16], 1103 (1928).—Production of Portland cement in March was reported by the U. S. Bureau of Mines at 10,223,000 bbl. This represents a seasonal gain over the 8,797,000 bbl. of February. A.J.M.

In the cause of architecture. FRANK LLOYD WRIGHT. *Arch. Rec.*, **64** [2], 99–104

(1928).—W. makes a plea for more esthetic treatment of cement. No medium of expression has yet been found that will allow it to take plastic form. It should be possible to design a pattern for casting to feature the flow of material distinguishing the concrete by its artistic expression from stone. Another possible plastic treatment is printing en masse while fresh, cameo or intaglio style. Illustrated. E.B.H.

BOOK

The German Cement Industry. RIEPERT, QUIETMEYER, SCHOTT, AND HAEGERMAN. 1099 pp. Published by Zementverlag, Charlottenburg, Germany. 1927. Reviewed by P. H. Bates in *Rock Prod.*, **31** [20], 70–71 (1928). F.P.H.

PATENTS

Phosphorus. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 287,036, May 2, 1928. Phosphorus and an aluminous cement are obtained by melting phosphates, under reducing conditions, in an electric or a shaft furnace with a slag formed by fusing, under reducing conditions, 70–90 parts of alumina with 30–10 parts of lime. Bauxites of high iron content may be employed in forming the slag, the iron being eliminated in the fusion in the form of a regulus.

Cements. E. GOFFART. Brit. 294,111, Sept. 12, 1928. A slow setting cement having high initial strength is formed by increasing the alumina content of Portland cement and adding a protective colloid such as albumen, casein, gelatin, gum, algae, or starch. The alumina content may be increased by adding bauxite to the raw materials or by adding calcic aluminate to the fired materials during or after grinding. The colloid may be added dry during or after grinding or may be added to the gaging water. In an example, a cement comprises 1000 parts of Portland cement, 200 parts of calcic aluminate and 4 to 8 parts of casein. These are mixed in the dry state and gaged with water.

Enamels

Adhesiveness of vitreous enamels to metal. W. N. HARRISON AND G. T. THALER. *Jour. Amer. Ceram. Soc.*, **11** [11], 803–11 (1928).—A method of testing the adhesiveness of vitreous enamels to metal is developed. The test specimens are prepared by clamping together two strips of enameled metal while still in the furnace and allowing them to cool slowly in another furnace from a temperature of 500°C. The test consists of determining the force necessary to pull the two metal pieces apart when treated as a continuous strip of metal under tensile stress. As a source of additional data in analyzing results, an estimate is made of the percentage of contact area on each specimen within which failure occurred in the bond. The adhesiveness of an enamel containing cobalt, manganese, and nickel oxides is compared with the enamel minus these oxides. The cobalt enamel gave a much stronger bond than the cobaltless enamel, a result which is in agreement with industrial experience. The degree of reproducibility is sufficient to permit positive distinction between conditions of adhesiveness which differ considerably.

The aging of enamels. ANON. *Amer. Enameler*, **1** [7], 3–5 (1928.)—Aging reduces the yield value of an enamel slip to a point where it can be brought back to the proper consistency by artificial means without affecting the mobility. Where there is no time for aging the slip, the use of slaked clay in grinding produces the same effect. M.E.M.

Use of gas in enameling. C. C. KRAUSE. *Amer. Enameler*, **1** [8], 4–5 (1928).—A gas-fired furnace without muffle was substituted for a coal-fired full muffle furnace in a plant making enameled sanitary ware by dry process. Production was thus increased 42%. In the new furnace 11,380 lbs. of iron were enameled per 24 hrs. with an average gas consumption of 37,500 cu. ft. M.E.M.

Development of wet process through research. A. I. ANDREWS. *Amer. Enameler*, **1** [8], 10–11 (1928).—Historical. M.E.M.

Continuous driers improve metal enameling. ANON. *Chem. Met. Eng.*, **35**, 561 (1928).—The continuous drier at the Louisville Enamel Products Co. is illustrated. M.E.M.

Overcoming cleaning difficulties. C. S. HOUPT. *Enamelist*, **5** [9], 22–23 (1928).—H. describes a heating coil for cleaning tanks. It is made of 1-in. pipe and return bends, suspended on the side of the tank, and a piece of sheet iron fastened in front of it, extending from 2 in. from the bottom of tank, to 2 in. above the coil, and under the surface of the solution. A flow of solution is thus set up from tank to coil. M.E.M.

New methods decrease costs. E. R. GUYER. *Enamelist*, **5** [10], 10–12 (1928).—The Cribben & Sexton stove plant is described and illustrated. M.E.M.

Production system for refrigerator enameling. ANON. *Enamelist*, **5** [10], 28–36 (1928).—Methods are described and flow sheets given for the Servel plant. M.E.M.

Sheet steel for automobile bodies. ANON. *Blast Fur. Steel Plant*, **16** [9], 1192–98 (1928).—The normalizing of sheet steel is discussed and its development reviewed. Mechanical equipment, metallurgical control, and resulting properties of the sheets are described. F.P.H.

Step-ladder furnace for enameling. ANON. *Ceram. Ind.*, **11** [4], 370–73 (1928).—A description is given of the Chicago plant of the Edison Electric Appliance Co. The furnace is a continuous "U" type, 60 ft. long on the interior and heated intermittently with 575 k.w. During its first month of operation, the furnace was firing 2500 sq. ft. of ware per hour. It operates on three 8-hour shifts. When pushed to capacity, however, it gives a better performance than this. A 150-foot conveyer chain carries the sprayed ware into and out of the furnace moving from 2 to 14 ft. per minute, and is motivated by a 2 H.P. motor regulated by a speed reducer. The efficiency of electricity as a fuel is again established in this instance, the heat being automatically controlled with two pyrometers to within 10°. The noteworthy thing about this furnace is its construction, which enables it to retain all the heat in the heating chamber. The furnace is built on an angle of approximately 35° in step-ladder fashion with the heating chamber centered in the topmost section. This arrangement pockets the heat in the sections where it is most required for efficient firing and prevents it from leaking out of the furnace at the entrance and exit. This is the first furnace of this type in operation, and its savings in fuel alone and more thorough firing due to its construction are obvious. It does the work of about 3 or 4 of the box-type furnaces and requires 3 men. In the walls of the furnace proper $13^1/_2$ inches of Sil-O-Cel was set with 9 inches of fire brick, and on the roof there is $13^1/_8$ inches of Sil-O-Cel and 4 inches of fire tile. The atmosphere about the furnace is comparatively comfortable and no fans are needed to cool the workmen. F.P.H.

Enamel spray booth. ANON. *Ceram. Ind.*, **11** [4], 374 (1928).—The booth is about 4 feet wide, 3 feet deep, and 3 feet high. A protective shield catches any of the dust which may blow back toward the operator. A frame which leaves a 2-inch border around the rear face of the booth is cut out, and in this frame is set the so-called baffle plate. This sheet iron plate projects out from the frame about 2 inches, and also leaves at the top and bottom a 2-inch space between the baffle and the rim of the frame. The sides are cut on a slant, the space between the top of the baffle and frame rim measures $3^1/_2$ to $3^3/_4$ inches, while the distance at the bottom is 2 inches. Punched in this baffle are 8 holes. The 3 holes at the top are 2 inches in diameter, the middle 2 are about $^1/_4$ inch less in diameter. The exhaust is obtained by a single 4-foot fan placed at a point central to all spray booths. The exhaust pipe is 12 inches in diameter where it enters the booth and graduates down to about 8 inches at the junction with the main exhaust pipe. All of the enamel with the exception of the finest dust is laid on the

bottom of the booth and none escapes into the room. The spraying pressure is close to 70 pounds. F.P.H.

Continuous enameling of gas stove parts. ANON. *Iron Age*, **121** [10], 665 (1928).—This new unit is a combination of a furnace and a traveling conveyer. Both the ground and finish coats are fired onto the steel and the drying operation is included. Thus no separate drying oven is required. The conveyer is of the continuous chain type and is in the form of a closed loop. The parts to be enameled are suspended from the conveyer. At both ends of the conveyer the chain engages large horizontal sprockets. The conveyer is 119 ft. long. On the driving end the conveyer extends 39½ ft. beyond the furnace; at the idler end it projects 19½ ft. beyond. The furnace is of brick and is 60 ft. in length. Dipping tanks and spraying booths are arranged along the exposed portions of the conveyer, so that work, as soon as it is covered, is hung on hooks suspended from the chain. The work enters the furnace through small openings provided for that purpose. The furnace is divided into zones along its longitudinal axis. The heating zone occupies 10 ft. in the middle. The preheating and drying zones are located at the ends and take up the remainder of the space, or 50 ft. The hot ware emerging from the heating chamber runs parallel with, but counterwise to, the cold work which has just entered the furnace. There is a rapid transfer of heat from hot to cold ware and fuel consumption is reduced. A semimuffle divides the heating zone into two longitudinal chambers, kept at different temperatures for different classes of work. The temperature in one is set at the proper degree for the ground coat and in the other for firing on the finish coat. Heat is supplied by 16 gas burners located on the sides of the heating zone. One side of the conveyer is continuously loaded with ground coat, while the other side fires white or finish coats. A.J.M.

Overcoming blistering in enameled cast iron. ANON. *Iron Age*, **121** [16], 1072 (1928).—Blisters on enameled cast-iron ware may be traced either to faulty enamels and process of application or to the castings themselves. Differences in the blistering tendencies of different sets of castings were clearly brought out by an enameling test which included a variety of firing treatments. Using this test it was found that not only do different irons have different blistering tendencies, but successive heats of the same iron may have different blistering tendencies. The main source of blisters from the irons used in this work was removed by the removal of a thin surface layer of the castings, either through mechanical or chemical means. A.J.M.

Enameling furnaces with producer gas firing. G. KÖRRN. *Keram. Rund.*, **36,** 221–23 (1928).—A construction of gas channels is described which permits removal of tar without interruption of operation of the producer. At the lowest part of the gas channel a sump is provided with one or more pipes of suitable size through which the tar flows to a large reservoir with its bottom at a lower level than the sump. Tar may be removed from the larger reservoir through an opening above. H.I.

Enamel technology and enamel science. RICHARD ALDINGER. *Keram. Rund.*, **36,** 381–83 (1928).—The disagreement between values for coefficient of thermal expansion on enamels as measured and calculated from the values of Winkelmann and Schott and of Mayer and Havas for the different oxides is discussed. The measured values may vary with the type of raw materials used although chemical composition may remain constant. The modulus of elasticity of enamels is important since high elasticity may prevent failure which would otherwise result from a large difference in the expansion coefficients of enamel and iron. In general, enamels with high elasticity have low expansions and vice versa. Usually enamels with higher elasticity and lower expansion than the iron give better results than enamels with lower elasticity and higher expansion than the iron. Methods of calculating the fusibility of an enamel from the composition are generally not satisfactory. A. pleads for more exact and more numerous measurements of fundamental properties of enamels. H.I.

Enameling, with special reference to modern enameling ovens. A. BRESSER. *Korrosion Metallschutz*, **4**, 157–60 (1928).—A discussion of the construction of modern enameling ovens with sketches showing the different types of firing. (*C. A.*)

Enamels containing antimony. F. M. LITTERSCHEID. *Z. Untersuch. Lebensm.*, **55**, 296–97 (1928). (*C. A.*)

The variable results of the bending test as applied to the testing of cast iron. F. ROLL. *Giesserei-Ztg.*, **25**, 114–19 (1928).—The transverse test of cast iron does not give approximately regular results as in the case of tensile tests on steel, the properties being affected by small differences in chemical composition, cooling conditions, and structure. The causes of the variations are discussed, and an endeavor is made to correlate them. (*J.I.S.I.*)

Effect of chemical composition on the structural volume analysis of high-duty cast irons. J. L. FRANCIS. *Iron and Steel Ind.*, **1**, 87–89 (1927).—As a "standard" cast iron for high-duty purposes the following composition is taken:

	(%)
Combined carbon	0.9
Graphitic carbon	2.1
Silicon	1.0
Sulphur	0.1
Phosphorus	0.2
Manganese	1.0

The structural volume analysis of this iron is:

	(%)
Manganese sulphide	0.5
Iron-carbon-phosphorus eutectic	2.9
Graphite	6.9
Iron silicide	3.6
Pearlite	85.7
Cementite	0.3

The effects of alterations of the amounts of each element present are discussed, and a table is presented showing approximately quantitatively by what amounts the structural volume analysis is altered by 0.1% variation in the content of each element. Finally, a simple calculation is explained by which it is easily decided whether a cast-iron casting of a composition somewhat different from the "standard" has developed the maximum pearlitic matrix possible, the condition which is, of course, desired in a high-duty cast iron. (*J.I.S.I.*)

Planning an enameling shop for high-quality work. P. B. MCBRIDE. *Iron Trade Rev.*, **81**, 1287–89 (1927).—A brief discussion of the problems to be considered in the design and construction of an enameling plant. The arrangement of sandblast, pickling, milling, dipping, spraying, drying, and other equipment requires special care if the enameling operations are to be carried out efficiently. (*J.I.S.I.*)

Improved enameling process. F. W. MANKER. *Iron Trade Rev.*, **82**, 619–23 (1928).—The methods and equipment of the American Stove Co., for the enameling of stoves are described and illustrated. Continuous automatic gas-fired enameling furnaces are in operation. (*J.I.S.I.*)

Recent developments in metal spraying. R. A. PARKES. *Metal Ind.*, **32**, 201–203, 249–51, 273–74 (1928).—The latest apparatus for metal spraying is described, and the properties and characteristics of the coatings in various metals are discussed. (*J.I.S.I.*)

Recent developments in cast iron. J. G. PEARCE. *Metallurgist*, pp. 25–26, 39–42 (1928).—P. first discusses problems connected with the testing of cast iron, properties of the metal, and attempts that have been made to correlate the properties with the structure and composition. He then describes the hot-mold process, giving details of the composition of the iron, mold temperatures, etc., with complete test results on three

specimens. Low-carbon iron and its production are next discussed. As the phosphorus in this material is invariably kept low, fluidity is attained by suitably increasing the silicon content. In Germany the low carbon is attained by the use of steel scrap in the cupola charge, while an American process employs a carbon-free silicide, such as calcium silicide, to render a white or mottled iron gray. The last section deals with chilled irons, which, owing to their silicon content, become gray and machinable on chilling. This metal has a small grain-size and resists fluid pressures well.

(*J.I.S.I.*)

Mechanical tests of cast iron. A. PORTEVIN. Swiss Assn. for Testing Materials, *Report*, No. 3, Dec. (1926).—A general review of the properties, constitution, and structure of cast iron, and of the methods of testing the physical and mechanical properties. (*J.I.S.I.*)

BOOK

The Ready Remedier. KARL TURK. Waverly Press, Baltimore, Md. 124 pp.—A manual for porcelain enameling superintendents. Reviewed in *Western Soc. Eng.*, **33**, 157 (1928). (*C. A.*)

PATENTS

Enameled sheet-metal tile. WINGATE THOMAS. U. S. 1,687,355, Oct. 9, 1928. A connected set of fractional-length flanged enameled sheet-metal tiles, comprising a plurality of fractional-length tiles, and webs connecting the flanges of the tiles, the webs being narrower than the flanges.

Decorative effects on enameled goods. "SFINX" SPOJENÉ SMALTOVNY A TOVARNY NA KOVOVE ZBOZI, PKC. SPOL. Fr. 634,669, May 19, 1927. Drops of solutions or glazing or mixtures of the 2 are applied to ceramic objects before glazing and firing or after glazing and before firing to produce decorative effects. (*C. A.*)

Glass

Further work on large glass disk. ANON. Bur. Stand., *Tech. News Bull.*, No. 137, pp. 127–28 (1928).—Method of removing foreign particles from the surface of the 70-in. reflector previous to examining it for strain is described. The disk was stood on edge and examined for strain or quality of annealing by means of plane polarized light and was found to be symmetrical with respect to the shape of the disk. The maximum strain detected produced a relative retardation equivalent to 6 millimicrons per centimeter thickness. A description of method of drilling an 8-in. hole in the center of the disk is given. The purpose of a hole in a reflector is to permit the use of the Cassegrainian type of mounting in which the partially converged light is reflected by a secondary mirror back through the hole to the observer's position. R.A.H.

Annealing and leaching of chemical glassware. H. LÖBER. *Sprechsaal*, **61** [9], 160–62; [10], 181–83 (1928).—Glasses of 5 different hydrolytic classes were tested to determine the effect of a leaching solution (Na_2O) on unannealed chemical glassware (flasks and test tubes) and after annealing one, two, and three times. The classes of glassware tested include (1) water resistant, (2) tough, (3) hard, (4) soft, (5) defective. Values and charts are given to show increased resistance to leaching with each additional annealing treatment. R.A.H.

Improvements in the glass industry. ARENDT. *Sprechsaal*, **61** [11], 201–203 (1928).—A general discussion of the German glass industry, number of persons employed, furnaces and types, temperatures, output per person of different types of ware, and how automatic machinery is gradually replacing human labor. R.A.H.

Melting opal glass. ANON. *Ceram. Ind.*, **11** [4], 375 (1928).—It is believed impossible to melt an opal glass containing bone ash for 18 hours, considering that a systematic working schedule is absolutely essential and that a melt and a working period in a

hollowware glass works must be completed inside of 24 hours in order to operate the plant on a paying basis. The following glass compositions have positively been melted in Tschernitz N.-L. and Baruth i.d.M., Brandenburg, and belong probably to the oldest opaque glasses which were produced on a factory basis. These compositions are dated 1850 to 1890 and were worked under the melting and working conditions described above. Bone ash glass compositions with reference to present day raw materials are given below.

Tschernitz N.-L. (1850–1890)

Compositions	(1)	(2)	(3)
Sand	150	135	100
Potash	60	60	50
Bone ash	45	30	30
Red lead	12	10	15
Whiting	5	6	
Potash niter	5	3	
Arsenic	2	0.5	1
Borax, calc		3	2
Tin oxide		2	
Mixture (lbs.)	279	198	198

Baruth I. M.

Compositions		Analysis	Per cent
Saltpeter	27	SiO_2	59.3
Potash	27.5	K_2O	9.3
Sand	130	CaO	21.2
Bone ash	53	P_2O_5	9.6
Lime	25.5	As_2O_5	0.2
Arsenic	2	PbO	0.4
			100.0

F.P.H.

Gravity flow process vs. suction feed process. V. B. M. PEARSON. *Ceram. Ind.*, **11** [4], 376–78 (1928).—The mechanical efficiencies of the flow machine are discussed. The gravity flow process permits the economic operation of relatively small automatic formers. For each former one feeder only is required, and it is possible to arrange for one feeder to serve up to three machines. The cost of a feeder or feeders to serve a flow forming aggregate unit is less, of course, than the corresponding charges for the installation of a revolving pot furnace to serve a suction machine for an equivalent output. The operation costs may, in certain circumstances, be lower. The cost of glass as delivered to the machine is certainly lower with the gravity flow process than with the suction process under the present conditions of working employed by the latter. The fuel required for the revolving pot furnace in the Owens process is not necessary in the gravity flow process, and so is saved. Again, the working end of a gravity flow furnace may be held near 1200°C, while with the suction process, as previously mentioned, the glass is delivered into the revolving pot at 1350 to 1400°C. It requires about 2000 to 2500 pounds of fuel to melt the glass for the suction process per ton of glass produced, including that required for the melting furnace, the revolving pot furnace and the leers. About 1000 to 1200 pounds of fuel per ton of glass produced is required for the gravity flow process, including the fuel for the melting furnace and leers. A certain amount of gas is necessary to operate the feeders and the cost of this must be charged against the process. However, improvements in feeder design and operation are cutting down this gas considerably. In any case, the cost of the gas used on a feeder does not amount to the disparity in the fuel costs between the two processes. F.P.H.

Improvements in manufacturing flat glass. J. W. CRUIKSHANK. *Glass Ind.*, **9** 10], 217–20 (1928).—A written discussion of "Manufacture of Flat Glass," by H. K.

Hitchcock, (see *Ceram. Abs.*, **7** [7], 436(1928) taking up new methods of manufacturing flat glass, including the Ford, the Fourcault, and the Bicheroux processes.

E.J.V.

Applications of glass to chemical and allied industries. A. E. MARSHALL. *Pottery Gaz.*, **53** [616], 1589–91(1928); for abstract see *Ceram. Abs.*, **7** [11], 751–52(1928).

E.J.V.

Window-glass production in Denmark. ANON. *Pottery Gaz.*, **52** [616], 1638(1928). —The industry of window-glass production is about to be started in Elsinore, where previously the seat of window-glass production had been. The Danish Window Glass Factory (known as the Castle Factory) was established in 1906. For some time it was out of action. It opened in 1912 but had to be stopped again for want of coal, the supply being interrupted by the war. The revival is based on foreign capital.

E.J.V.

New glass factories in Hungary. ANON. *Pottery Gaz.*, **53** [616], 1638(1928).—The erection of new glass factories in Hungary is now acquiring some degree of importance. Although existing factories have been quite able to meet the home demand, two new factories, owing to their modern plant and equipment, will be able to cut down foreign competition. One of the concerns, a table glass factory, is being erected with Czechoslovak capital, while the other is being built with Belgian capital and equipped in accordance with Belgian patents. E.J.V.

German glass trade. ANON. *Pottery Gaz.*, **53** [616], 1638(1928).—The exports of hollow and table glassware declined in June. Customs duties in certain countries are making themselves felt with steadily increasing acuteness. Countries, which formerly were the best buyers of German glassware, have now started glass industries of their own, which are not only more than covering the home demand, but even leave an increasing surplus, which is enabling them to compete successfully with Germany. Czechoslovakia, in particular, is pursuing a policy of protection in her own glass industry. Belgium, by highly increased production has secured a market of growing importance and is underselling German goods. Recently the union of German wholesale dealers in table glass was formed with 22 firms. The Union proposes to open several special trade sections. Felix Singer states that Germany has the advantage of possessing large sources of raw material of good and uniform quality. E.J.V.

Belgian glass industry. ANON. *Pottery Gaz.*, **53** [616], 1638–39(1928).—In spite of the greatly increased production, due to machine processes, the situation in the Belgian glass industry is slowly improving, mainly because of the considerably reduced production costs resulting from the use of machinery. This improvement is also partly due to the formation of the selling bureau. A single organization, similar to that in the mirror glass industry may possibly regulate production and sales. The machine glassworks are making quite large profits. The negotiations between the Belgian representatives and the Americans regarding the proposed increase in the American import duties appear to be difficult. Though Belgian exports to the U. S. may be lessened owing to the increase in the duties, Belgian producers expect to find compensation in other markets. The mirror-glass industry would be the hardest hit by the increase, as the U. S. is by far its best customer. E.J.V.

Oil-engine compressor effects savings. J. S. MEEHAN. *Amer. Glass Rev.*, **47** [45], 15–17(1928).—The T. C. Wheaton Co., Millville, N. J., still blows its glass by hand because its products are extremely varied. A high grade of lime glass is used. The batch is melted either in pot furnaces or tank furnaces depending upon the character of the glass and the quantities to be handled. Although lime glass answers for many services, still it is not suitable for containers designed to hold chemicals and therapeutic preparations. Therefore, in order to protect such preparations a special glass is produced, named "Nosolvite." Colored ware is conspicuous among the products of this

plant. In some cases the coloring matter is added to the glass while it is in a molten state, and in other instances the coloring matter is applied to the glass after the ware is formed and then made permanent by firing in the furnace. The plant is equipped with 2 pot furnaces and 4 tanks for the continuous melting of glass. One of the pot furnaces and all the tank furnaces are fired with oil sprayed with compressed air. Frosting is done by dipping the ware into hydrofluoric acid. If the bottle is to be given a crackle finish, it is heated suitably and then dipped into water. E.P.R.

Soda ash. ANON. *Amer. Glass Rev.*, **47** [46], 16 (1928).—"Columbia Alkalis" is a booklet issued by the Columbia Chemical Division of the Pittsburgh Plate Glass Co., and contains much information and tabular material regarding the various alkalis, including both dense and light sodas. There are also useful conversion tables. All users of soda ash will find something of value in the tabular matter. Distribution of the booklet is through Issac Winkler & Bros., Inc., the Columbia sales agents. E.P.R.

Melting glass by electricity. ANON. *Amer. Glass Rev.*, **47** [49], 15–17 (1928).—Methods of utilizing electric power for melting glass on a commercial scale has formed the subject of experimentation since 1881. Only within the last few years has the question entered the field of practical application. Bjorn Raeders holds a high position among those responsible for the advances. There are two ways in which the application of electricity for glass melting can be done: (1) by the electric arc, (2) by resistance. There are several inherent disadvantages in the use of the electric arc. Because of the intensely local heat and high temperature there is danger that the alkali will be lost. Also the local heating has considerable effect on the surrounding brickwork, and expense and trouble in connection with the constant renewal of the carbon electrodes for the arcs, while there is still trouble with glass discoloration from the particles of carbon from the electrodes. All these difficulties can be obviated by the use of the indirect resistance-heating, but this in turn introduces other difficulties, *e.g.*, loss of efficiency due to having to transmit heat through the clay forming the pot in which the glass is melted; the pot itself is troublesome and there is difficulty in obtaining satisfactory resistance material. There is, however, a system which overcomes all the above objections. At ordinary temperature glass is a nonconductor of electricity, but when heated to a molten condition it becomes a conductor. The result is that it is possible to use the molten glass itself as the electrical resistance element, the heat being generated inside the body of the molten mass. Furthermore, contrary to all other processes of melting glass, the heating of the glass takes place in every part of the batch. In addition, it becomes possible to accelerate the rate of melting to a figure impossible with any system of heating by flame, resulting in a reduction of the dead weight capacity of the furnace. The initial cost of the electric installation is decidedly the lower, as gas producers, boilers, coal storage, flues, etc., are entirely eliminated. E.P.R.

The manufacture of glass. F. C. FLINT. *Nat. Glass Budget*, **44** [14], 23 (1928).—Though the use of glass is old, it was a crude product for centuries. Even in old times the glassmaker had his factory near the source of supplies. As the industry developed he went farther afield for his materials. Glass is composed of the same materials as are rocks. Sand forms three-fourths of the material of which glass is composed, while varied amounts of different minerals are added to produce color. Cobalt acts like bluing on clothes. It takes only one part in 400,000 to take out the green color in glass, while one part in 20,000 gives a dark blue glass. Selenium in small amounts helps the blue to neutralize the green and in larger amounts gives the glass a pink color. Boron keeps the glass from shrinking so that it will not crack on cooling. Safety glass was at first made with wire rolled into it while the glass was hot, now safety glass is bonded with celluloid. It is made by gluing two layers of thin glass together with a piece of celluloid. Some of this type of glass is even bullet-proof. E.P.R.

Heat economy office aids German glass industry. ANON. *Nat. Glass Budget*, **44** [15], 18 (1928).—A report of the business year of the Advisory Heat Economy office of the German glass industry, an organization founded by the Assn. of Glass Industries of Germany, has just been made. It covers the eighth annual meeting which was held July 1, 1928, in Berlin. A committee was elected to continue the study of heat economics. E.P.R.

The glass industry in 1927. ANON. *Keram. Rund.*, **36**, 231–33, 252–53 (1928).—Economic conditions in the German glass industry are described. In general conditions were somewhat better in 1927 than in preceding years, although there was increased competition from other contries, notably Czechoslovakia. H.I.

History of the glass industry in Bavaria. P. MARTELL. *Keram. Rund.*, **36**, 244–47 (1928).—Glass works were in operation in Bavaria at least as early as 1340. Production was rigidly controlled by the rulers of the region and associations of glassmakers were fostered for this and other purposes. The German glass works of the 16th Century used generally a glass batch consisting of sand, or crushed quartz where sand was not available, with ashes of birch, maple, fir, and pine. The use of these ashes often introduced NaCl and Mn into the batch. Cullet was also used. In the Böhmerwald region, glass works for the manufacture of containers and mirrors were in existence in 1566. In the 15th and 16th Centuries German glass manufacture suffered from the competition of Venetian glass works. To prevent increasing competition the Venetian republic passed rigid laws forbidding artisans in the glass industry to leave the country. In Bavaria, Nuremberg was the center of the mirror industry. Stress of competition compelled the mirror makers of Nuremberg to associate and to provide for themselves a common market. The introduction of Venetian foil-backed mirrors affected the Bavarian industry seriously until the art of foil-backing was brought to Nuremberg by fugitives from the English religious persecutions. In the 18th Century the manufacture of spectacle lenses was an important industry in and around Nuremberg. These were exported to Spain, Holland, Italy, and Russia until imports of these articles were forbidden in many of these countries. The Fichtelgebirge were the center of a decorated glass industry using a basic glass of a greenish tint decorated with an opalescent glass. H.I.

The influence of magnesium oxide on the resistance of glasses. M. A. BESBOROdow. *Keram. Rund.*, **36**, 365–68 (1928).—In a glass with the composition SiO_2 67.91%, Al_2O_3 3.97, Fe_2O_3 0.03, CaO 9.00, B_2O_3 2.43, Na_2O 9.51, K_2O 7.06, MgO was substituted for CaO in increments of approximately 2% to a maximum of 8.27%, the percentage amounts of the other oxides remaining approximately constant. The resulting glasses, made up in the form of beakers of 400 cm.^{3} capacity, were tested by boiling for an hour with 2 *N* NaOH solution, with 2 *N* Na_2CO_3 solution, and with 20% HCl solution. After each treatment the loss in weight was determined. The results were as follows: (1) An increase in MgO and decrease in CaO decrease the resistance to NaOH solution. (2) Substitution of MgO for CaO increases the resistance to Na_2CO_3 solution until a maximum is reached at 5.78% MgO. Further increase in MgO causes a decrease in resistance. (3) Substitution of MgO for CaO decreases the resistance to HCl solution until a minimum is reached at 5.78% MgO. Further increase in MgO increases resistance. Observations on the refining and working qualities of the glasses indicate that the viscosity and surface tension of the glasses increase with increasing MgO. The difficulty of melting increases with increasing MgO and in general the substitution of MgO for CaO is not advisable. H.I.

Melting experiments with alumina bearing rocks. LUDWIG SPRINGER. *Keram. Rund.*, **36**, 403–406, 426–28 (1928).—Glass melting experiments were performed using a glass of normal composition and substituting for quartz sand, either wholly or in part, (1) quartziferous feldspar sand, (2) pumice, (3) greenstone, (4) "Erlan-Gestein," a

mixture of an epidote-bearing granite and epidote- and hornblende-bearing quartzite. The substitutions were in general so made that the per cent by weight of $SiO_2+Al_2O_3+Fe_2O_3$ and of Na_2O+K_2O+CaO were approximately constant. S. concludes that (1) several of these materials have valuable qualities as components of the batch, either as the principal raw material in ordinary glasses, as a coloring medium for green or dark glasses or as admixtures in special glasses; (2) Al_2O_3 in glasses up to a certain amount is not only not harmful but may be beneficial in improving the chemical stability and assisting in fusion; (3) the use of these substitutes may cause an appreciable saving in alkaline batch materials since the rocks themselves contain alkalis or other constituents which are satisfactory as fluxes; (4) disadvantages of these substitutes are (*a*) the cost of grinding, (*b*) the high Fe content of some of them, (*c*) the difficult fusibility and high viscosity of the glass when too much of the substitutes is used. H.I.

Window glass transparent to ultra-violet light. SALMONY. *Chem. and Ind.*, **47,** 935 (1928).—Recently glasses have been produced which transmit light of wave-lengths less than 3200 Å, to which ordinary window glass is practically opaque. They are boric glasses, made from the ordinary materials but of special purity. Specimens 2 mm. thick gave 55 to 85% transmission at 3100 Å, and 1 to 15% at 2750 Å. Glasses of this type have been developed which can be fused to the glass of ordinary incandescent lamps. Their widespread use is expected in hospitals and similar institutions. The price is 2 to $3^1/_2$ times that of ordinary window glass. H.H.S.

Neutral glass for vials. MARIO GIORDANI. *Atti congresso naz. chim. pura applicata*, **2,** 818–29 (1926).—As the result of his study of the effect of the heavy metals in glass and devitrification, G. concludes that the appearance of glass heated with water in an autoclave (etching) is not to be confused with devitrification. The ZnO content of the glass is without influence in producing either of these phenomena. The test for alkalinity involving the use of $HgCl_2$ is not very sensitive. Heavy metals need not be prescribed for their presence confers many notable advantages upon the glass, such as greater resistance. Furthermore it has not been demonstrated that they cause devitrification. The maximum sterilizing temperature for vials is 120°. (*C. A.*)

New views on the chemical constitution of glass. O. KNAPP. *Chem. Rundschau Mitteleuropa u. Balkan*, Sept. 30, p. 155 (1927).—Glass was considered most probably to be, chemically, a silicate in mutual solution in free acids and bases. From a physicochemical point of view it was suggested that those substances were to be considered as glasses which possess at the temperature prevailing below the equilibrium curve a liquid phase corresponding with the field above the curve. (*C. A.*)

The electrochemical behavior of silicate glasses. V. J. B. FERGUSON, M. J. MULLIGAN, AND J. W. REBBECK. *Jour. Phys. Chem.*, **32,** 1018–30 (1928).—When a glass sample is electrolyzed at moderate temperatures with a difficultly soluble anode material like Hg, the current decreases as the electrolysis proceeds. This decrease is caused by the setting up of counter e.m.fs. and by an increase in the true resistance of the glass sample. At low voltages the counter e.m.f. tends to assume a constant value. The minimum voltage which is required to give this nearly constant value increases as the electrolysis proceeds. The true resistance of a Hg-containing anode glass layer has been found to be many times that of the original glass and to change with temperature in accordance with the rule of Rasch and Hinrichsen. The smaller counter e.m.fs. constant values which are noted when glass samples are electrolyzed with a soluble anode and a mercury cathode have been attributed to chemical origin. The manner in which the electric measurements are affected by current reversal has been indicated for glass samples having Hg-containing anode glass layers. Hopkinson's experiment on residual charge was repeated under different conditions. (*C. A.*)

The action of carbon dioxide on glass at high pressures. O. K. BOTVINKIN. *Jour. Russ. Phys. Chem. Soc.*, **60,** 221–28 (1928).—One g. of powdered glass containing

50.84% SiO_2, 27.94% PbO, and 15.19% Na_2O besides Al, K, Ca, Mg, and Fe was covered with 10 cc. H_2O, subjected to 0–15 atmospheres of CO_2 for 1–24 hrs., filtered, and the filtrate titrated with HCl. Amounts of alkali plotted against time for 0, 5, 10, and 15 atmospheres gave almost parallel curves rising steeply at the origin and asymptotic to the time axis. The Na_2O-pressure curves are practically parallel to the axis of pressures. The action of H_2O and Na_2SiO_3 is accelerated by temperature; the amount of alkali liberated after a given time interval is proportional to the temperature. The total surface of the powder has a large influence on the velocity of hydrolysis. The CO_2 reaction constant decreases with time, probably because of diffusion through carbonate formed followed by rhythmic precipitation. The maximum amount of alkali dissolved was 10% of the total alkali. (*C. A.*)

The solidification of amorphous matter. S. ENGLISH. *Roy. Tech. Coll. Met. Club Jour.*, **1927–28** [6], 3–6 (1928).—Two methods were specially developed for determining the viscosity of glass with very great accuracy, one for use from a temperature of 1400° down to 200° above the annealing point of the glass, and the other for the range of 150° to 200° above the annealing point of the glass, the annealing point being defined as the lowest temperature at which internal strains may be removed by free movement of the glass mols. Viscosity curves for Na silicate glasses are approximate hyperbolas. Curves are also given of the mobilities of Na_2O-CaO glasses, showing that the replacement of Na_2O by CaO causes the viscosity at any given temperature to be progressively increased in proportion to the amount of Na_2O substituted. (*C. A.*)

The transparency of glasses for ultra-violet radiations. B. LONG. *Science Ind.*, **12**, 13–15 (1928).—Glasses of a thickness of 2 mm. can be divided into (1) those which absorb all or the greater part of the ultra-violet spectrum (they contain iron oxide, Ti, Cr, Ce, etc., and are mostly used for eye protection); (2) those whose permeability is less than 10% for radiations below λ 3100 A. U. (to this class belong the dense flint and barium glasses); (3) those which transmit rays with λ below 2900 A. U., and of small iron and titanium oxide content. Leaves of 2 mm. thickness were used in windows. Curves are included. (*C. A.*)

The light absorption of opal glass. G. GEHLHOFF AND M. THOMAS. *Z. tech. Physik*, **9**, 172–75 (1928).—For the average, absorption by opal glass bulbs was found 14 to 15% (0.8 mm. glass), the opacity being caused by fluorides. This absorption cannot be explained from the longer path of the light in the glass due to repeated reflections and absorption by the (Fe Mn) gray matter. Experiments on thick clear glass showed that this path was approximately only 3.9 times longer in opal glass. By complete removal of all Fe during the manufacture the absorption could be cut down to 11.6%, an insignificant decrease. Apparently the absorption is due to the opaque particles themselves (cf. Ryde and Yates, *C. A.* **21**, 2365) and not to the impurities in between. (*C. A.*)

PATENTS

Sheet-drawing apparatus. ENOCH T. FERNGREN. U. S. 1,684,437, Sept. 18, 1928. In sheet glass apparatus, means to draw a sheet of glass from a source of molten glass, including a sheet supplying meniscus, and heat absorbing means positioned on both sides of the sheet and having a curved end whereby the means can be placed relatively close to the sheet without interference to the sheet supplying meniscus, the lower extremity of the heat absorbing means being a substantial distance from the base of the sheet supplying meniscus.

Process and apparatus for maintaining sheet glass to width. ENOCH T. FERNGREN. U. S. 1,684,438, Sept. 18, 1928. The process of drawing sheet glass from a pot, consisting in containing a mass of molten glass, forming a sheet supplying meniscus thereon, and producing adjoined glass areas having relative viscosities at the base of the meniscus edges, the glass having the lowest viscosity being adjacent the pot walls.

Sheet glass edge-forming means. FRANK FRASER. U. S. 1,684,440, Sept. 18, 1928. In sheet glass apparatus, means for drawing a sheet from a mass of molten glass, stationary means arranged at the base of the sheet at its edges for retarding the movement of the glass entering the sheet edges, and rotable means arranged above the stationary means and closely adjacent thereto.

Molded-glass receptacle. JOHN E. MARSDEN. U. S. 1,684,498, Sept. 18, 1928. An article of molded glassware having an inner vertical partition therein leading upward from the bottom to the level of the top, and having a channel in the bottom surface of the bottom portion of the receptacle in the plane of the partition, whereby the mass of glassware at the bottom is accordingly reduced and distributed as to thickness.

Glass furnace. THOMAS B. HART. U. S. 1,685,053, Sept. 18, 1928. In a glass furnace, a drawing well, heating chambers on opposite sides thereof, suspended arches on opposite sides of the well adjacent the chamber, the arches being hollow and having outlet and inlet openings therein, a drawing block between the arches, and means for conveying products of combustion from the heating chambers to the hollow arches.

Apparatus for delivering charges of molten glass. LEONARD D. SOUBIER. U. S. 1,685,143, Sept. 25, 1928. (1) In a glass feeder, the combination of a container for molten glass having an outlet opening in its bottom, a plug or rod of refractory material projecting downward through the glass over the outlet, the lower end of the plug being tapered and protruding through the outlet, and means providing a heated chamber enclosing the protruding end. (2) In a glass feeder, the combination of a container for molten glass having an outlet opening in its bottom, a core extending downward in the glass over the outlet concentric therewith, a regulator, and means to move the regulator spirally about the axis of the core toward and from the outlet.

Temperature-controlling means. JAMES BAILEY. U. S. 1,685,348, Sept. 25, 1928. In a device for the annealing of glass articles, the combination with a rotating chamber to receive the articles, of means for heating the chamber, a controller for regulating the heat so imparted, and means for actuating the controller comprising a member having rolling contact with the end of the chamber and adapted to be shifted by the expansion thereof.

Apparatus for and process of finishing blown-glass articles. JAMES BAILEY. U. S. 1,685,349, Sept. 25, 1928. A finishing machine comprising means for supporting the article to be finished with the implement on which it was made suspended therefrom, and means for simultaneously annealing the article and separating it from the implement.

Glass-feed-control mechanism. SAMUEL G. STUCKEY. U. S. 1,686,109, Oct. 2, 1928. In an apparatus for controlling the feed of molten glass, the combination of a tubular member with an open end adapted to be immersed in a body of molten glass above a discharge opening, an air conduit leading from the upper portion of the tube, a cylinder with which the conduit connects, a control piston movable in the cylinder, means for reciprocating the piston to cause alternate conditions of pressure and vacuum in the tubular member above the molten glass therein, control means for varying the quickness of movement of the control piston to produce pressure conditions, and other control means to vary the quickness of movement of the piston to produce vacuum conditions, such control means being operable independently of each other and of the speed of the apparatus as a whole.

Method and apparatus for surfacing plate glass. JOHN H. FOX. U. S. 1,686,742, Oct. 9, 1928. Apparatus for surfacing plate glass comprising a series of driven grinding and polishing runners, a track therebeneath, and two sets of cars or tables adapted to form a continuous train and carry on their upper surfaces the sheets of glass to be surfaced, the tables or cars being divided into two sets of fixed levels, with the level of the top surfaces of one set lying at an elevation which is less than that of the level of

the top surfaces of the other set by a predetermined distance corresponding to the thickness of glass which is removed from the sheets by the surfacing operation.

Glass manufacture. R. SALOMON. Brit. 294,216, Sept. 12, 1928. Relates to a method of, and apparatus for, making glass tubing or rod by drawing the glass vertically upward from a pot or container. According to the invention, the whole or part of the mass of glass in the pot is given a rotary movement about the axis of drawing in order to mix the glass and render it homogeneous. The drawing pot has an annular cover formed with a cylindrical sleeve that dips into the glass. The pot is kept charged with glass from a tank furnace by means of a spout inserted through an opening and the temperature of the glass is maintained by a gas flame which is directed along the space within the cover. Another form of drawing-device consists of pairs of grippers which move up and down parallel secured rods the rotation of the rods being reversed when the grippers reach the limits of their movement. The grippers of each pair engage the tube in turn, and when each reaches the top of its screwed rod, the tube is cut, the gripper turns through 180° and discharges its section of tubing, and then moves downward again. While it is moving downward, the drawing is continued by a gripper of the other pair.

Glass annealing ovens. NAAMLOOZE VENNOOTSCHAP MAATSCHAPPIJ TOT BEHEER EN EXPLOIT VAN OCTROOIEN. Brit. 294,258, Sept. 12, 1928. Glass plates are moved through the hottest part of an annealing oven by pushing mechanism which remains within the oven. Three pusher members are carried by inverted U-shaped supports the vertical limbs of which pass into side recesses below the glass-supporting surface of the oven where they are connected by longitudinal bars. These bars rest on rollers carried by rails which are in turn supported by transverse beams suspended by rods from the overhead rocking-levers. The pusher member can be raised and lowered by levers and moved lengthwise of the oven by an endless chain. The side bars and the supports may be made hollow for the circulation of cooling air, and the supports may be additionally protected by a covering of heat-insulating material. Operation plates are fed into the oven, one or more at a time, from traveling tables by a stowing tool, and are then advanced step by step by the pushers which are lowered behind the plates, advanced by the chains, raised, and then retracted for a fresh cyle of movements.

Preventing weathering of glass. K. KAMITA, AND ASAHI GARASU KABUSHIKI KAISHA. Brit. 294,391, Sept. 12, 1928. A process for preventing the clouding of glass by atmospheric influences consists in allowing a gas consisting of, or containing, an acid gas to act on the surface of the glass at an elevated temperature. Air or furnace gases containing sulphur dioxide, sulphur trioxide, hydrogen chloride, or other acid gas or vapor, are allowed to act on the surface of the glass while it is maintained at about the annealing temperature. The surface becomes covered with a white powder which is wiped off when the glass is cool.

Heavy Clay Products

Drying brick. ANON. *Brick Clay Rec.*, **73** [7], 432–36 (1928).—A description of the Colbert drier being used at the Fiske & Co. plant in Darlington, Pa., is given. It was designed by C. L. Colbert, chief engineer for Fiske & Co., and is a 5-tunnel drier, 85 feet long, drying 45,000 brick in 8 or 9 hours, with only 366 brick on a car, which means that the brick are dried in a little less than 3 hours. The construction and operation of the drier are discussed. Its installation increased production in the plant from 35,000 to 90,000 brick per day, and the company was confronted with the problem of getting a greater grinding capacity and at the same time a better quality of ground material without putting too much investment in grinding equipment. A ring-roll crusher to grind dry pan tailings solved the problem and has greatly increased the percentage of fines. E.J.V.

Efficiency in a small plant. ANON. *Brick Clay Rec.*, **73** [7], 437–42 (1928).—A description of the plant of the Emaus Brick Co., of Emaus, Pa., which manufactures 30,000 brick daily in four 39-foot round kilns with 25 men. The Minter system of drying and firing has been installed and is working with great success. The use of modern methods has brought the cost of production down and the quality of product up. Details of the operations used are given. E.J.V.

Clay products in Fair Grounds buildings. ANON. *Clay-Worker*, **90** [3], 181–82 (1928).—The buildings on the Indiana State Fair Grounds show the trend toward clay products in the use of state funds for building purposes. The excellent use of brick, terra cotta, and roofing tile puts the Indiana State Fair in the front rank in the U. S. E.J.V.

Clay preparation. ANON. *Clay-Worker*, **90** [3],183 (1928).—What may be termed the forerunner of success in the making of clay products is the mixing and preparation of the raw materials used. In this there are several points to observe and study: (1) thorough and uniform mix; (2) efficient preparation; (3) dependability of the equipment used; (4) whether soft mud or stiff mud is used. Efficient preparation calls for continued research, and for keeping informed on new ideas and developments. Preparation of raw material is part of the secret of low cost and profitable operations. By studying machinery and visiting other plants where it is in use, one can find out in advance what will serve best in each case, thus effecting profit through more efficient production. E.J.V.

Suer Brothers brick plant. ANON. *Clay-Worker*, **90** [3], 189–91 (1928).—A description of the brick plant of Suer Bros., near Lawrenceburg, Ind., where 30,000 brick per day are made, using an alluvial clay which is won by means of a clam-shell bucket. Details of plant equipment are given. Firing is done in scove kilns holding approximately 500,000 brick each, using coke for watersmoking and Pocahontas egg coal for the actual firing. The total force on the yard consists of 26 men. E.J.V.

Factory design and equipment. XVIII. T. W. GARVE. *Clay-Worker*, **90** [3], 200–201 (1928).—Labor requirements vary with the locality and the layout of the plant and also with the output to a very great extent. Another influencing factor is the newness of the enterprise. A discussion of data on labor used in clay plants of Ohio as published in *Circular*, No. 14, Ohio State Univ., Eng. Expt. Sta. (see *Ceram. Abs.*, **7** [7], 500–502 (1928)), is presented and some labor data based upon man power rather than factory or clay conditions are added. For previous abstracts see *Ceram. Abs.*, **7** [11], 759 (1928). E.J.V.

New equipment for brick driers. ANON. *Clay-Worker*, **90** [3], 201 (1928).—A new brick drier door of all-metal frame construction is made to fit very tight and because of the material is fire-resisting. A unit consisting of 4 doors in 2 pairs is sufficient for a 2-track drier. It can be used either for new driers in which case it is built into the building, or it can be inserted as a unit in remodeling an old drier. The door is not only easy to handle and fire-resisting, but is built of excellent insulating material and helps to maintain conditions inside the drier at exactly the point the operator desires. Under severe tests in which this type door has been tested for the last 2 years it has shown most gratifying results and its success has been very wide-spread in the lumber dry kiln field. The same success may attend its introduction into the brick drier field because its price is moderate and its quality and effectiveness very high. It is a product of the Standard Dry Kiln Co. E.J.V.

Magnetic control for modern slag plant. W. H. MCKAY. *Blast Fur. Steel Plant*, **16** [9], 1209–10 (1928).—In the preparation of slag for utilization efficient design requires unusual motor controls in regulating the starting and stopping of crushing, conveying, and screening machinery. F.P.H.

Mortar: its importance in the life of brickwork. J. A. VAN DER KLOES. *Rock Prod.*, **31** [20], 60–62 (1928); for abstract see *Ceram. Abs.*, **7** [9], 615 (1928). F.P.H.

Effect of workmanship on strength of brick masonry. J. W. MCBURNEY. *Amer. Arch.*, **132** [2532-II], 613–18 (1927).—The data on this problem were collected through the testing of 159 brick walls and obtained coöperatively by the Bureau of Standards and the Common Brick Manufacturers' Assn. The results may be summarized as follows: (1) Workmanship characterized by filled vertical joints and ungrooved horizontal joints will give an increase of strength over the results of workmanship characterized by unfilled vertical joints and grooved horizontal joints from 24% to 112%. (2) Where horizontal joints are ungrooved and vertical joints are filled, no effect is produced on compressive strength by shoving as compared with slushing or dashing. (3) Other things being equal, the thinner the mortar joint the stronger the masonry. (4) The percentage increase in strength secured by using filled and ungrooved joint workmanship over the other type diminishes with increase in strength of the brick. R.A.H.

Defects due to drying: causes and cures. ANON. *Brit. Clayworker*, **37** [437], 221–22 (1928).—Among numerous defects which occur during the drying of various articles, one of the most serious is that known as scum. This may be due to soluble salts which during the drying are brought to the surface of the ware, or more frequently to the condensation of acid moisture from the kiln gases in the fresh or "drying off" stage of firing in a continuous kiln. The latter form of scum may be prevented by heating the goods in clean air until they are at too high a temperature for condensation to occur. When such gases are drawn through a kiln in such a manner that they come into direct contact with the goods to be dried the formation of scum is almost certain. Heat radiated from gases passed through a tubular air-heater may be used to avoid scumming during drying. If in the kiln a hot air system is used for the first stage of the firing the scum may be completely avoided. Scum due to soluble salts in the clay can be avoided by mixing barium carbonate with the clay and rendering the salts insoluble. Cracking due to core moisture may be overcome by carefully drying the articles in question. Irregular drying often is the cause of cracks. The commonest cause of cracks in drying is the formation of a hard surface crust through which the moisture in the interior of the goods cannot easily escape with the result that as drying continues and such moisture is converted into steam it develops a pressure which eventually becomes great enough to cause the goods to crack. Insufficient grinding, soaking, pugging, and storage lead to many defects in drying. Pieces of stone or gravel often cause cracking in clay goods. These must be either ground to a powder or removed entirely from the mix. R.A.H.

Cimita ceramic: new clay for heavy ware manufacture. ANON. *Brit. Clayworker*, **37** [437], 230–31 (1928).—An enormous quantity of this peculiar clay, which has been given the name "cimita" occurs in the province of Coquimbo, Chile. The nonplastic part of most clays is silica, but in the case of this material it consists chiefly of feldspar totalling 41.35% divided as follows: combined silica 27.67%, alumina 13.31%, potassium oxide 0.22%, sodium oxide 0.15%. The plastic part of the clay showed the following analysis: silica 26.45%, alumina 21.95%, iron oxide 0.4%, lime 0.16%, potassium oxide 3.52%, combined water 5.0%. The experimental work on this unctuous rock brought to light the peculiar properties of this natural product and it was made clear that it could be directly used for industrial purposes. It also appeared that the mixture of clay and feldspar in this natural product was so close as to suggest the possibility of dispensing with extremely fine grinding in practical work. The fired product is a very hard, firm stoneware, with a very fine grain and perfectly vitrified texture. Use of this clay eliminates many difficulties in the manufacture of heavy ware such as baths, lavatories, etc. R.A.H.

Paper coverings for wet clay. ANON. *Brit. Clayworker*, **37** [437], 235 (1928); for abstract see *Ceram. Abs.*, **7** [10], 704 (1928). R.A.H.

Slag bricks and paving stones in Germany. A. GUTTMANN. *Arch. Eisenhüttenw.*, **1**, 339–44 (1927).—Processes in use in Germany for the manufacture of slag building bricks are indicated, and the suitability of blast furnace slags for such purposes is discussed. The properties of the bricks are described and methods for testing their strength suggested. (*C. A.*)

Methods of using barium carbonate for scum prevention in stiff-mud brick. L. P. COLLIN. Can. Dept. of Mines, *Invest. in Ceram. and Road Mat.*, No. 690, 5–7 (1928).—Because of the increased popularity and use of rough-textured brick manufactured by the stiff-mud process, the problem of scumming or efflorescence is becoming of increased importance. In several brick plants efflorescence is prevented by the addition of from 1 to 3 lbs. of $BaCO_3$ per ton of clay. The factor of primary importance is to obtain a thorough mixing of the Na_2CO_3 and clay. There is no definite evidence as to the superiority of the wet or dry method for addition of the $BaCO_3$. (*C. A.*)

Tests of clay and concrete load-bearing pipe. W. J. SCHLICK. *Proc. A.S.T.M.*, (preprint 66), 12 pp. (1928).—This paper discusses some of the more common problems of test procedure. Particular attention is given the problems encountered in the use of the two most common of the standard bearings, sand bearings, and three-edge bearings, in tests of different sizes and classes of pipe and to the necessity for controlling the moisture and temperature of the specimens if truly comparable test results are to be obtained. The real meaning and value of the absorption test are discussed and certain common but incorrect procedures in the drying and immersion treatments are pointed out. The freezing and thawing test is the only direct durability test that has been standardized. The problems of durability against chemical attack have been solved only partially. (*C. A.*)

Concerning the granulation of slags. B. BOGITSCH. *Rev. de Métallurgie, Mémoires*, **24**, 695 (1927).—Further details of the use of a compressed air jet to prevent explosions during the granulation of slags and metals are given with precautions to be taken in carrying out the process. (*J.I.S.I.*)

PATENTS

Open-top drier. CLAUD E. FULLER. U. S. 1,685,047, Sept. 18, 1928. In an open top drier of the kind described, the combination of a base, a plurality of parallelly arranged compartments formed on the top thereof, in air inlet chamber arranged at one end of each of the compartments and being connected to each compartment, an air outlet chamber arranged along the other end of the compartments and being connected to each compartment, a heating coil arranged in the bottom of each compartment, the compartments being adapted to be filled with a plurality of containers, which containers form a top for the drier.

Building block. CARL A. DWYER AND WILLIAM A. WHEELER. U. S. 1,686,270, Oct. 2, 1928. In a building block, a bearing face providing a rib defined by angularly related plane surfaces and like grooves defined at opposite sides of the rib by angularly related plane surfaces, and a 2nd bearing face providing a groove and ribs respectively complementary to the 1st rib and grooves, the height of the rib of the 1st face being greater than the depth of the grooves with respect to a plane defined by the top edges of the grooves.

Machine for erecting walls of brick and the like. STEWART KAYE. U. S. 1,686,279, Oct. 2, 1928. A machine for erecting walls of brick and the like comprising in combination upright structures, a cross member extending between and joining the upright structures, the member being adapted to straddle two parallel walls being built, brick-laying mechanism carried by and adapted to travel on the cross member, and means whereby

the brick laying mechanism may be traversed to lay a course of brick on each of four rectangular walls or cross walls in succession.

Building block or tile construction. HARRY D. FOSTER. U. S. 1,686,373, Oct. 2, 1928. In a hollow wall, a plurality of integral hollow units each having mortar-supporting face shells and a plurality of cross and longitudinal shells and webs which are individually incompetent to sustain mortar, two longitudinal webs being arranged close together to sustain mortar, the units also having end projections on the cross shells in the line of the face shells and longitudinal webs whereby to support spaced mortar joints, and spaced mortar joints on the face shells and juxtaposed longitudinal webs and on the end projections to connect the units, whereby at least two independently sealed and separate air chambers are formed in the wall intermediate its faces.

Building tile. JOHN GERALD MACVEIGH AND PAUL B. COLLINS. U. S. 1,687,342, Oct. 9, 1928. A building block comprising a body member having a plurality of chambers extending longitudinally therethrough and a plurality of grooves in the upper side thereof, a longitudinally disposed rib carried by the under side of the body member, an outwardly extending horizontally disposed flange carried by one side of the body member adjacent its lower side and having a longitudinally disposed channel therein, a chambered downwardly extending longitudinally disposed flange carried by the outer end of the horizontally disposed flange and disposed below the block, a longitudinally disposed rib carried by the lower side of the downwardly extending flange, the ends of the body member adjacent their inner sides being provided with vertically disposed chambers.

Brick machines. N. OUCHOW. Brit. 294,729, Sept. 19, 1928. In the manufacture of hollow bricks in which the clay is subjected to a final compression in the closed mold with the cores in position, fixed molds are used having definite bottoms, sides, ends, and lids, and a sliding end plate independent of the end of the mold is arranged to be pushed forward by the cores during the last portion of their forward movement to apply the final compression to the clay. After the mold has been charged and closed, the cores are advanced by rack-and-pinion gear to pierce the clay. One side and end of the mold also swing as a unit to open the mold for removal of the brick.

Brick and tile. J. DUNLEVY AND R. JOHNSON. Brit. 294,760, Sept. 19, 1928. Clay plastic compositions for brick and tile consist of glassmakers waste sand 60%, brickmakers clay 35%, and limestone 5%.

Refractories

Variations in pyrometric cone equivalents of silica cements and fire clays. SANDFORD S. COLE. *Jour. Amer. Ceram. Soc.*, **11** [11], 855–58 (1928).—In order to determine what variations might occur due to the method of preparing the sample for the pyrometric cone equivalent test, 100 silica cements and 5 fire clays were tested using (1) the cement "as received," (2) ground to pass a 65-mesh Tyler screen, and (3) after calcining at 1400°C, grinding to pass a 65-mesh Tyler screen. The pyrometric cone equivalent values were obtained by two operators, the cones being made by one operator. It was found that testing of silica cements "as received" gave closer checks than ground samples The grinding of the sample lowers the pyrometric cone equivalent $1\frac{1}{2}$ to 2 cones in general.

Physical properties of glass tank block refractories. A. ERNEST MACGEE. *Jour. Amer. Ceram. Soc.*, **11** [11], 859–67 (1928).—Porosity, crushing strength, elasticity, specific gravity, transverse strength, thermal expansion, impact strength, and resistance to heat shock were determined on five glass tank block refractory bodies. Ability to resist heat shock was successfully predicted from the elasticity, transverse strength, thermal diffusivity, and thermal expansion values.

Effects of coal ash on refractories. T. N. MCVAY AND R. K. HURSH. *Jour. Amer. Ceram. Soc.*, **11** [11], 868–73 (1928).—The action of coal ash on the following types of

refractories was studied: (1) high diaspore brick, (2) fireclay refractories with very little quartz, (3) fireclay refractories with considerable quartz, (4) refractories containing a mixture of diaspore and fire clay, and (5) andalusite refractories. The tests were carried out in a rotary test furnace at temperatures ranging from 1500 to 1600°C. The phases present in the coal-ash refractory slag were identified by means of the petrographic microscope and consisted of magnetite, mullite, and glass. The effects of time of slag action and slagging temperature were studied.

History of the refractories industry. J. D. RAMSAY. *Clay-Worker*, **90** [3], 192–94 (1928); see also *Ceram. Abs.*, **7** [4], 236 (1928). E.J.V.

Manufacture and use of refractory formers for electric heating elements. P. COOPER. *Pottery Gaz.*, **53** [616], 1605 (1928).—Service conditions under which electrical heater elements have to work are outlined; the problems to be overcome in order to supply a satisfactory article, the difficulties in some cases of manufacture, and the progress made in recent years are discussed. The chief qualities of a first-class refractory former for electrical heating are: thermal strength, reasonable mechanical strength, sufficient electrical resistance at maximum running temperatures, negligible variation in size, material which will enable production to be carried out easily and cheaply, and in some cases, color according to demand. It was obvious that refractory formers could not be made from one standard formula. Continual adjustment of body mixtures might be necessitated by variation in design, size, electrical loading, color, and different processes of manufacture. As the use of electricity for heating purposes grows and conditions become more severe, old ideas of a fire clay being "good enough" must be discarded. Test apparatus must be installed to prove the value of the various necessary characteristics. Many kinds of fireclay marls, china clays, and ball clays have been used in recent experiments, in addition to silica, steatite, zirconium, bauxite, and other materials. The results have shown that to produce satisfactory articles the same care must be exercised and the same precautions taken with the materials as when making the highest-class ceramic porcelains. E.J.V.

Functions of regenerators in relation to refractory materials of construction. A. T. GREEN. *Pottery Gaz.*, **53** [616], 1607–1611 (1928).—During the period of heat absorption the regenerator brickwork takes up a store of heat ample for requirements of the furnace working. This recuperation of heat from the products of combustion is influenced by (1) thermal conductivity of brickwork; (2) heat capacity of brickwork; (3) total weight and disposition of filling, which includes the thickness of the brick and the area of the spaces; and (4) time during which recuperation continues, *i.e.*, the period between reversals. Further, the effective regeneration of heat depends, among other factors, upon similar considerations. Regenerator design is a compromise between thermal, mechanical, and operation considerations. According to Clements, the several factors involved in the provision of an efficient system of regeneration could be stated as follows: (1) shape and dimensions of the chamber should be such that the gases during regeneration and recuperation are evenly distributed over the whole of the checker work, thus bringing all parts of it into service; (2) the weight of suitable brickwork provided to form the checkering should be sufficient to ensure a store of heat ample for regeneration without a wide range of temperature variation; (3) the effective heating surface presented by the checker work must be ample to allow for a rapid heat exchange, and the arrangement of checkers must be such that the particles of gas are brought into intimate contact with the hot surfaces. Summing up the evidence on the thermal properties of possible regenerator fillings, the following inferences might be drawn: (1) magnesite products appear to possess thermal advantages from the aspects of heat storage and thermal conductivity; (2) fireclay brick are very efficient thermal agents, absorbing and transmitting comparatively large quantities of heat; (3) silica products have high values for

temperature diffusivity and give up their heat more rapidly than fireclay brick. By reason of their low apparent specific gravity, however, silica brick have comparatively low heat capacities, thus making the quantity of heat stored and transferred to the gases less than with fire clay or aluminous brick. (4) Siliceous brick appear to compromise the thermal properties of silica and fireclay products. (5) According to S. M. Phelps, aluminous refractories have comparatively high apparent specific gravities and heat capacities. Thus, they are effective thermal storage agents. They would form efficient regenerator bricks from a thermal standpoint. (6) Recrystallized silicon carbide, possesses a high thermal conductivity and a low specific heat. By virtue of this high conductivity, this material cools rapidly, especially a relatively small quantity of heat to be dissipated. For checker work, brick of this composition would be of little value except in an operation where rapid reversals of the regenerators are essential. (7) Differences in regenerator efficiency can be obtained by the use of fireclay brick of varying porosity. The denser the brick the more efficient it is in checker operation. Generally, such a brick is more resistant to slag action than one of open structure. (8) S. M. Phelps states that, on experimental evidence, the glazing of bricks during industrial usage does not impair their thermal efficiency. This is to be expected, since a very large quantity of heat is given up by convection from the surface of the brick and the function of convection is not appreciably affected on changing the nature of the surface by glazing it, since the surface film is of substantially the same area before and after glazing. An investigation of the fire clay and siliceous material applied for regenerators showed that a great variety of products was used for this purpose. In the selection of suitable refractories, magnesite bricks, although possessing desirable thermal properties, were ruled out on account of cost and spalling tendency. Silicon-carbide refractories, for open-hearth refractories, failed from thermal, economic, and operational considerations. Highly aluminous refractories, although possessing certain effective regenerator properties, would not appear to be a better proposition (when their cost was considered) than superior fireclay products. From economical considerations the choice appeared to be between silica, siliceous, and fireclay bricks. Silica products, owing to the high temperatures in the top courses, were usually considered essential for these positions, although highly siliceous products would withstand the conditions. The data available suggested that the silica brick was less efficient, judged from the point of view of thermal capacity, than fire brick or siliceous products; it maintained the spacings during an economical life; its salvage factor, however, was doubtful. Both siliceous (90% SiO_2) and superior fireclay products found effective use as major regenerator fillings. In general, the siliceous material appeared to possess the best compromise to properties, particularly when slagging and superficial "stickiness" effects were considered. When considering the best properties of the fire brick, it is essential to bear in mind that the term fire brick is a comprehensive term and includes a great variety of products differing profoundly in constitution and properties. Properties required in the fire brick are: (1) nonspalling qualities; (2) structural strength and a noncontractile nature; (3) a hard-fired structure so far as was consistent with nonspalling qualities; (4) enhanced thermal characteristics, starting with a well conceived texture. It is desirable that the material should not warp or lose shape owing to contraction taking place during the high temperature of working. A full knowledge of the firing properties and contractile nature of the clay is, therefore, necessary in order to insure that the possibility of volume alteration is reduced to a minimum. Supplementing this knowledge, the behavior of the product under loads of 20 to 25 lb. per square inch should be known, as this indicates the contractile or viscous properties of the fire brick at working temperatures in the neighborhood of 1200°C. A full appreciation of these data would prevent the use of materials which "sag," warp, show appreciable surface softening, and, in some cases, actually fuse.

E.J.V.

Jointing cements for refractory structures. CYRIL EDWARDS. *Pottery Gaz.*, **53** [616], 1611 (1928).—E. discusses the preparation and properties of jointing cements used in connection with silica and fire brick in the maintenance of furnace structures, outlining the types and properties of cements for particular purposes, working qualities, grain size and texture, shrinkage, and adherence to brickwork. The problem of preparing an ideal jointing cement for any particular purpose still awaits solution; but much might be accomplished by endeavoring to produce a good working cement which has the same composition and physical properties as the brick with which it is to be used. "A Comparison of the Properties and Industrial Durability of Lime-bonded and Clay-bonded Silica Bricks," by W. J. Rees and Hugill, and "The Dissociation of Carbon Monoxide in Contact with Fire Clays and Silica," by W. J. Rees, are treatises of an academic nature, accompanied by tables and diagrams, presented at the meeting of the Refractory Materials Section, Ceramic Society, Sept. 13 and 14. E.J.V.

Drying cracks in fire clay. C. E. MOORE. *Pottery Gaz.*, **53** [616], 1611–12 (1928). —M. deals with drying cracks as found in cases where the failure is due solely to the faulty conduct of the drying operation, whereby uneven drying and consequent strain is produced; and such cases in which faulty mixing, extruding, molding, or pressing constitute the original cause. There is a limit to the rate of drying, and the danger zone occupies that part of the drying process when the properties of the clay are changing, as follows: (1) movement of water through the mass rapidly becomes more difficult, (2) rate of contraction with loss of water is decreasing, (3) strength is slowly increasing. The maximum safe rate of drying in this stage may be increased by (1) delaying the reduction in ease of movement of water, (2) hastening the decrease of the contraction rate or the increase of strength. Other points are (1) effect of size and shape of grog employed; (2) drying on hot floors; (3) imperfect mixing of clay and tempering water; (4) inclusion of air in the plastic clay during the mixing process, and (5) extrusion difficulties. E.J.V.

Channel brick for foundries. ANON. *Brit. Clayworker*, **37** [437], 220–21 (1928).—The conditions under which such brick are used are very severe and even when the greatest care is taken in their manufacture the results will be abortive unless the raw material is suitable. It is exceedingly difficult to obtain satisfactory channel brick if the fire clay is ground dry and then wetted because the water is uniformly distributed through the mass. A wet method of preparation appears to be essential for working, though where prolonged storage of the pugged paste is practicable, dry grinding followed by pugging may be used. The addition of a small proportion of grog $^1/_{12}$ in. or less in diameter, appears to be an advantage. Neither the clay nor the grog must contain ironstones as any cast iron passing through the blocks in a channel will attack such stones first. A suitable material will become vitrified when fired to cone 9 (1280°C), but will not lose its shape or shrink materially at that temperature. A stoneware clay is most suitable for this purpose. Method of manufacture is described in the article. Channel bricks while not intrinsically difficult to make, need so much attention to detail that only those firms which specialize in their production can produce them profitably. R.A.H.

Refractories for patching and monolithic construction. C. PRESSWOOD. *Fuel Economist*; *Brit. Clayworker*, **37** [437], 224–25 (1928); *Refract. Jour.*, **3** [34], 874–76 (1928). —Patching and ramming materials may be classed as siliceous materials (ground ganister used for patching and lining cupolas, converters, and crucible holes) or fireclay materials (used for building and repairing boiler furnaces). Patching materials are generally finer ground that those used for ramming one piece monolithic linings, but both are made up of graded particles bonded with the smallest amount of plastic clay necessary to give strength and plasticity. Monolithic and brick construction are analyzed as follows:

Monolithic construction	Brick construction
(1) Careful drying needed.	(1) No problem of drying and shrinkage.
(2) Material undergoes firing shrinkage.	(2) No volume changes when first heated up.
(3) Only part of wall is strongly heated; cooler parts may crumble.	(3) Whole wall is hard and able to support weight.
(4) No joints.	(4) Brickwork is open to attack at joints.
(5) Unskilled labor may be used.	(5) Skilled labor needed.
(6) Repaired with same materials.	(6) Replacements troublesome and often unsatisfactory.
(7) Cheaper than brick in the long run, if not in first cost.	(7) High quality brick, of accurate shape and size, are costly.
(8) No special shapes necessary.	(8) Special shapes are necessary.

It may, however, be argued (*a*) that the "joint" problem is much less serious now that good cements and accurately shaped brick are obtainable; (*b*) that to avert failure in the case of monolithic work much care is needed and so the employment of unskilled labor may be risky; (*c*) that the care required to produce first class plastic refractories may cause them to be as expensive in first cost as bricks of good quality, or even more so. The essential characteristics of a good plastic refractory are enumerated as follows: (1) sufficient bond, cohesion, plasticity, or green strength to enable it to stay when rammed into position, (2) good drying characteristics, (3) insignificant volume change on firing to highest furnace temperature and no cracking or spalling, (4) elasticity and toughness to prevent detachment of heated surface portion, (5) mechanical strength to be preserved over a wide range of temperature, (6) uniformity, (7) adequate refractoriness. These desirable properties depend on the bond clay used, the aggregate and its grading, the moisture content, and the elastic properties of the constituent parts of the mixture. A very plastic clay answers best, so that by using minimum proportion the shrinkage may be kept as low as possible, and at the same time mechanical strength may begin to develop at as low temperatures as possible. The most satisfactory plastic refractories have for aggregate calcined fire clay or grog which is carefully graded as to size. Moisture content should be so controlled as to give maximum plasticity without causing excess shrinkage. Deficiency of moisture would cause decrease in strength. R.A.H.

Malleable foundry refractories. Bur. Stand., *Simplified Practice Recommendation*, R79-28, Feb. (1928).—Stock shapes and sizes of brick and tile for malleable foundry refractories are limited to the following: Door opening tile (2); tap-out blocks (2); shapes for side walls, bridge walls, etc. (8); shapes for bungs and roofs (5); shapes for round stacks (1). Eighteen shapes are listed and drawings showing dimensions given. R.A.H.

Sagger investigation. ANON. Bur. Stand., *Tech. News Bull.*, No. 137, p. 129 (1928).—The moduli of elasticity and rupture at room and elevated temperature, and the thermal expansion from 20 to 1000°C have been determined on specimens of 20 different sagger bodies. These data were obtained to establish the value of the "resistance to thermal shock factor R" (described in *Tech. News Bull.*, No. 120) which would give an indication of the probable life of a particular sagger body. The data obtained on fired sagger bodies show that the resistance factor "R" gives a fairly good indication as to the life of the sagger when subjected to repeated thermal shock, if referred to a group of bodies containing only fine grog or a group containing only coarse grog. It does not appear to apply when comparing the life of a coarse grogged sagger with that of a fine grogged sagger. It was also found that (1) saggers containing only a porous grog showed greater resistance to thermal shock than those containing a partially vitrified grog; (2) the rate of thermal expansion of the fine bodies was higher than that of the coarse bodies in 67% of the observations, similar in 20%, and lower in 13%; (3) a comparison of the thermal expansion of the sagger bodies with that of the two clays composing each of the bodies shows that in 12 out of the 15 instances the combination was advantageously made with respect to either or both clays. R.A.H.

Fused quartz. FELIX SINGER. *Sprechsaal*, **61** [12], 221–22 (1928).—Discussion on the preparation and properties of fused quartz and how it differs from ordinary quartz. Comparisons of such properties as compressive strength, elasticity, dielectric strength, etc., are made with other ceramic materials. R.A.H.

Constitution of refractories. ANON. *Blast Fur. Steel Plant*, **16** [9], 1233–36 (1928). —Refractory materials consist essentially of crystals held compactly together by a glassy cement. Therefore the nature, size, and shape of the crystals, and the character and amount of glassy cement, must be factors of first importance. In the case of natural refractories, such as silica and clay materials, there are always inevitably a number of air pores present, and the properties are considerably modified by the nature and number of these voids. These voids are often a source of much trouble, and the chief feature of a cast refractory is that it has practically no porosity, and this is frequently a highly desirable property. But apart from this, all the mentioned groups of refractories are characterized by the presence of numerous crystals, of one or more types, in a glassy matrix. Modern metallurgy is based to a large extent on the study of temperature-property curves of alloys, combined with microscopical examination of the structural changes involved in defined heat treatments. In a similar manner much of the knowledge of refractory complexes depends on the use of the microscope in conjunction with a study of temperature-property characteristics. By the aid of the petrological microscope it is possible to examine either thin sections or powdered samples of refractory materials, and by so doing valuable information can be obtained concerning the identity and distribution of the crystals. F.P.H.

Austrian magnesite industry. ANON. *Rock Prod.*, **31** [20], 55 (1928).—During 1927, Austria exported 97,000 metric tons of burnt magnesite which contributed in excess of $4,000,000 to the nation's trade. Prior to the World War, Austria enjoyed a near monopoly of the world's supply for dead burnt magnesite in 1913 having exported 123,000 metric tons. During the war, however, some of the nations either introduced substitutes or found workable deposits within their own territories. The most important Austrian deposits are located to the southwest of Vienna in the states of Styria and Carintha. Most of the deposits are massive and crystalline and are close enough to the surface to be worked by open cuts. There are at present 6 magnesite companies incorporated in Austria, one of which is largely controlled by American interests. Of the 5 Austrian companies, 3 are corporations with a total capitalization of over $3,000,000, while the other 2 are private undertakings. The whole Austrian magnesite industry employs approximately 2500 workers. F.P.H.

Better refractories for high temperatures. ANON. *Chem. Met. Eng.*, **35**, 569 (1928). M.E.M.

Softening of refractories by heat. STUART M. PHELPS. *Refract. Jour.*, **3** [33], 842–43 (1928); for abstract see *Ceram. Abs.*, **7** [3], 169 (1928). E.P.R.

The importance of tests at high temperatures. ALFRED B. SEARLE. *Refract. Jour.*, **3** [33], 844 (1928).—As refractory materials are used at high temperatures it might be supposed that they would be tested when at a temperature corresponding to that at which they are to be used. In only a few instances is this the case, and many refractory materials are bought either without any tests at all or only after tests of minor practical importance. The great importance of tests run at high temperatures is emphasized and discussed in detail. E.P.R.

New developments in gas-works carbonizing plant, emphasizing refractory materials. G. M. GILL. *Refract. Jour.*, **3** [33], 845 (1928).—G. has given much attention to the subject, and first describes the developments in the U. S., Germany, and England. He considers that contracts for new installations of carbonizing plants are likely to range chiefly between continuous vertical retorts and intermittent vertical retorts, with a smaller number of horizontal retorts and ovens. The two vertical systems have some

advantageous features, and most gas engineers will almost certainly adopt a method of bulk carbonization in new installations. Intermittent vertical ovens are enlarged modifications of the Dessau system of vertical retorts. The new ovens are much larger in all dimensions except height, which must not exceed 17 ft. The intermittent vertical oven usually takes a charge of 1.35 to 5 T. of coal with a 12- to 24-hour carbonizing period; the coal being charged by a traveling wagon into 2 openings at the top of the oven, and the coke being discharged by opening the door in the bottom of the oven. The heating of these ovens is by producer gas burnt in the lower part of the oven, the hot gases passing upward and around the oven, then down through recuperators, and finally through a waste-heat boiler. E.P.R.

Refractory material used as mortar for laying-up refractories. D. A. MOULTON. *Refract. Jour.*, **3** [33], 846–47 (1928).—Pulverized fire clay of similar chemical composition to that of the refractory has generally been supplied for refractory mortars. Refractories are at present being laid, however, with a cement made of ground or calcined fire clay, with some bonding material to cause the mortar to harden. A short discussion of some of the outstanding high temperature cements is given. E.P.R.

Effect of substituting high silica sands for some grades in lime-bonded silica bricks. W. HUGILL AND W. J. REES. *Refract. Jour.*, **3** [33], 847 (1928).—The results obtained show that Lynn sand is more readily inverted than Totley ganister and that the substitution of 10% of Lynn sand in the brick mixture did not affect detrimentally the general properties of the bricks, although in certain cases lower bulk density and higher porosity resulted. E.P.R.

Silica and fireclay refractories. A. T. GREEN. *Refract. Jour.*, **3** [33], 859–64 (1928). —The Manchester and District Junior Gas Assn. visited the works of the Derbyshire Silica Fire Brick Co., Ltd., April 25. A paper discussing silica and fireclay refractories was presented. E.P.R.

German refractory materials. ALFRED B. SEARLE. *Refract. Jour.*, **3** [34], 873 (1928).—An interesting and valuable statement on the development of the ceramic industry in Germany, recently published by N. B. Jungeblut (see *Ceram. Abs.*, **7** [11], 792 (1928)) contains some important comparisons of the German refractories materials industry before and since the war. The leading firms in the industry appear, on the whole, to have almost recovered their dividend-paying power, though they show remarkable fluctuation. Other refractories, such as crucibles, muffles, saggers, and other hollow ware are now exported in more than double the largest quantities of pre-war days and the imports of these articles have fallen almost to zero. The export of salt-glazed drain pipes is now more than four times the 1914 figure. E.P.R.

Future progress in the field of refractories. STUART M. PHELPS. *Refract. Jour.*, **3** [34], 877–79 (1928); for abstract see *Ceram. Abs.*, **7** [7], 450 (1928). E.P.R.

Refractories in a developmental stage. G. A. BOLE. *Refract. Jour.*, **3** [34], 884–88 (1928); for abstract see *Ceram. Abs.*, **7** [6], 370 (1928). E.P.R.

Refractory material for vertical retorts. D. E. STEINHOFF. *Refract. Jour.*, **3** [34], 894–96 (1928).—Since 1923 research in refractories has been pushed forward vigorously in Germany. Different grades are required, silica bricks for the retorts, acid chamotte bricks for the recuperators, highly basic chamotte bricks for the most active parts of the producers, and second quality chamotte bricks for the back walls and insulations. The temperatures involved are relatively moderate, not exceeding 1350°C even in the walls. The pressures are considerable and call for care in designing. The weight of the charge presses on the walls. The action of gases also has to be considered. Alkaline vapors act chemically on the brick. For the vertical retorts there are four leading properties of the material which need attention: the expansion of heat, constancy of volume in the fire, the resistance to pressures at high temperatures, and the heat conductivity. The tests in ceramics are in general applicable to vertical retort work. E.P.R.

Research on refractories. J. B. FORTUNE. *Refract. Jour.*, **3** [34], 897–98 (1928).—In the iron and steel world the development of furnaces is dependent on the improvements in refractory material. Modern research divides utility into (1) strength, which is governed by rigidity and disintegration; (2) resistance to destruction, governed by abrasion, slagging, melting, and spalling; (3) confinement of heat, governed by heat capacity, transfer, and loss. The consideration of each of these points involves a number of properties and actual conditions. Rigidity is determined by such characteristics as bond, structure, fineness of grinding, density, degree of firing, and is influenced by such factors as stresses, temperature gradient of brick as affected by insulation and application of heat to more than one side, effects of slag and fluxes, and jointing materials and their thicknesses. Similarly the percentage of catalytic iron and the permeability of the brick are the deciding properties in disintegration, but are modified by composition of the furnace gases, tightness and material of joint, intermittent operation, and impingement of the flame upon the brick. Some interesting spalling tests were carried out recently by the Mellon Institute at Pittsburgh with a special furnace comprising 2 chambers, one of which was heated to the desired testing temperature, while through the other was passed a blast of cold air. A flat brick panel was built up of 20 bricks jointed with fire clay and subjected to practical wall pressures by set screws. This panel was brought to temperature in the hot flue and then transferred by a swinging arm to the air flue. It was found that the brick as manufactured would not spall much even if subjected to the most severe thermal shocks. If, however, the brick is heated for about 7 hours at a temperature of 1550°C before the test, a vitrification of the brick surface similar to that found in practice is produced. If after vitrification and cooling a spalling test of 10 cycles of 10 minutes cooling and 10 minutes heating to 1455°C is carried out, it is declared that the actual behavior of the brick in practice is accurately revealed. It is urged that all refractories should conform to specific dimensional limits, fire brick being the worst offender in this respect, while magnesite brick is the truest of all. Badly shaped bricks necessitate the use of more cementing material which is never as good as the brick itself. A glazed brick is more efficient in that it reflects more and absorbs less heat and light rays. First quality fireclay brick are found to have widely varying gas permeabilities according to the process by which they have been made. Hand-made brick are the most permeable, those made by the dry-press process are less permeable, and augur machine re-pressed bricks are the most impervious. The disintegration of refractories in the linings of blast furnaces has been the subject of investigation for a long time. The real cure is to use clay which is naturally pure or else to free clay from objectionable iron compounds by a process yielding iron-free clay. It was also found that the method of manufacture had considerable influence on the ease of disintegration. Augur-made bricks, being laminated by the way in which they are made, fracture along these lines of weakness, while steam-pressed bricks usually fail by longitudinal splitting. Hand-made bricks fracture irregularly. The whole question needs considerable detailed research. E.P.R.

Fire brick for boiler furnaces. W. A. CARTER. *Refract. Jour.*, **3** [34], 899–900 (1928); for abstract see *Ceram. Abs.*, **7** [8], 543 (1928). E.P.R.

Modern developments in glassmaking refractories. W. J. REES. *Refract. Jour.*, **3** [34], 903 (1928).—The article is the opening address to Joint Refractories Committee Meetings of the German Society of Glass Technology and the English Society of Glass Technology at Aachen, May 22. Much of the research work on refractories which has been carried out in England, Germany, and America during the past few years has been of direct service to the glass industry and has been applied with considerable advantage. References should be made to the recognition of the essential importance of adequate firing of refractories before bringing them into contact with molten glass. Laboratory and works' experience has shown conclusively the desirability of firing the

refractories, especially pots and tank blocks, at a temperature not lower than 1350 to 1400°C. The durability is increased and also a better quality of glass is produced, being freer from "stones" and striations. The increase in durability is due primarily to: (*a*) vitrification and lower porosity of the hard-fired refractory, (*b*) crystallization of mullite which accompanies vitrification, (*c*) reduced rate of solubility of hard-fired clay in molten glass. One of the most important developments in glasshouse refractories is the utilization of natural sillimanite. Extensive deposits are found in India and are now being used on a considerable scale in Europe and America. When bonded with from 5 to 30% of a plastic refractory clay, the calcined sillimanite is proving of great service because of its high refractoriness, excellent mechanical characteristics, and high resistance to the corrosive action of molten glass. It is especially serviceable for the "sieges," combustion chambers, and walls of pot furnaces, and for the feeding devices in machine production. Its durability in tank furnaces has been especially evident in bridge walls and in the working end. The recent development in America of blocks cast from fused materials of the approximate composition of mullite ($3Al_2O_3 \cdot 2SiO_2$) is of much interest. Data are already available showing the great durability of this fused product, but do not show conclusively whether its durability will fully compensate for its high cost. The silica brick of close texture, fired so as to secure complete inversion of the quartz to cristobalite and tridymite, has volume stability at glassmaking temperatures which makes it especially valuable for the roofs of tank furnaces. The ideal silica brick would have all its silica in the form of tridymite and would permit of more rapid heating than is possible with bricks containing cristobalite or quartz. Such bricks are, however, not yet practicable, although there is little doubt that a "catalyst" or "mineralizer" will be discovered which will sufficiently accelerate the rate of tridymite formation.

E.P.R.

Mining Grecian magnesite. J. R. THOENEN. *Eng. and Min. Jour.*, **125** [16], 644–48 (1928); for abstract see *Ceram. Abs.*, **7** [4], 237 (1928). A.J.M.

American crystalline graphite production in 1927. ANON. *Eng. and Min. Jour.*, **125** [21], 856 (1928).—The total production of graphite in the U. S. in 1927 was slightly less than that of 1926. However, the total value increased in 1927. Sales of graphite in 1927 were 5207 T. valued at $232,971, a decrease of 5% in quantity and an increase of 6% in value over 1926. The crystalline variety increased in both quantity and value. Alabama is the leading state in the production of crystalline graphite.

A.J.M.

German high-tonnage furnaces. F. H. WILLCOX. *Iron Age*, **121** [15], 1011 (1928).—Furnace construction in Germany is an inversion of that in America, *i.e.*, a brick stack with steel bands with cooling plates set in, and a steel plate bosh and tuyere jacket without plates, water-cooled on the exterior. The whole structure is supported on heavy structural framework extending to the top platform. Inwall cooling is carried right up to the stockline wearing plates. Large quantities of water are used on the bosh, tuyere, and hearth jacket with a run-off arrangement underneath the operating floor to prevent break-outs getting into the sewers. Furnace sizes vary, the largest having a hearth of 20 ft. 6 in., with a 24-ft. bosh and total capacity of 33,000 cu. ft. on a height of 95 ft. The furnace was credited with 985 T. average production. A.J.M.

Hot blast and powdered coal in cupolas. ANON. *Iron Age*, **121** [15], 1027 (1928).—The hot blast has not been worked out until recently. The change to continuous operation and long blast has made the hot blast cupola desirable. One company has installed hot blast cupolas in practically all its plants. The temperature of the blast is 400°F and with the use of the hot blast the coke requirement for a ton of iron has been reduced from 262 to 192 lb. The use of powdered coal in the cupola has been developed in Germany, with a material cutting down of the carbon monoxide that passes from the stack, this being 12 to 15% in ordinary cupola operation. The result has been a 30% saving in

fuel cost. The fuel is blown into the cupola at a high velocity, being introduced through special small tuyeres located 6 or 7 in. above the regular cupola tuyeres. A.J.M.

Design of galvanizing furnaces. M. EPSTEIN. *Iron Age*, **121** [17], 1151 (1928).—The usual design for coke furnaces in metalware plants gives no protection to the pot. The coke is piled into a combustion chamber, and the heat must be transferred directly into the pot at every available surface. Higher temperatures are thus produced in the combustion chamber. Coke-fired pots do not last long and great amounts of dross are produced. High dross formation means low pot life, the pot being eaten through from the inside. A furnace using gas burners near the bottom of the pot is effective; flames blow into refractory beds which causes immediate and complete combustion of the gas. Sides of the pot are protected with refractory tile resulting in doubling pot life and reducing dross 30 or 40%. In oil-fired furnaces the high-temperature zones are removed even farther from the pot. Illustrated. A.J.M.

Physico-chemical examination of the Borovitchi refractory clays. G. G. URAZOV AND N. I. VLODAVTZA. *Ann. Inst. Anal. Phys. Chem.*, **3**, 725–45 (1927).—Plastic clays have a higher water content than friable clays, as well as a higher titanium, iron, and alkaline-earth content. Three breaks may be observed in the temperature-time curves obtained by heating the clays to 1100°. The first two, indicating endothermic effects, occur at 100–110° and 400°, and are due to the loss of adsorbed and constitutional water respectively. The third, due to an exothermic reaction, takes place at 950° and is less marked for friable than for other clays. Curves connecting degree of dehydration of air-dry refractory clays with temperature show that at 400° 90% of the water originally present is given up; the remainder disappears at 520–600°. It is suggested that these clays consist of kaolinite, and that the air-dry clay ($Al_2Si_2O_7,nH_2O$) between 100° and 400° continually loses water, the resulting substance being hydrated leverrierite, $Al_2Si_2O_7,mH_2O$, which at about 600° is completely dehydrated. X-ray measurements of the angles of the crystal lattices of various Russian clays show that these are very close to one another and to those of nacrite. (*B. C. A.*)

Properties of refractories, their testing and behavior in operation. F. KANHÄUSER AND J. FLEK. *Chem. obzor*, **3**, 18–20, 44–46, 85–86, 103–10, 145–51 (1928).—The properties of ten refractories, their micro- and macroscopical structure, behavior in heat, and principal methods for testing are described. Determinations of refractoriness by a modified procedure of Endell, determinations of porosity by using Hartmann's volumeter, Endell's method of testing resistance to sudden temperature changes, and determinations of chemical resistance by using Hartmann's method are criticized. Photographs of apparatus and bibliography are added. (*C. A.*)

Refractories for brass foundry furnaces. H. M. ST. JOHN. *Metal Ind.* (London), **32**, 543–46 (1928). (*C. A.*)

Crucible melting furnaces. A. J. SMITH. *Metallurgist* (Suppl. to *Engineer* **146**, No. 4) 101–103 (1928).—An account of new designs used in Italy, France, and England. (*C. A.*)

Fused silica and its use in the chemical industry. A. MATAGRIN. *Rev. chim. ind.*, **37**, 85–89, 121–23, 178–82 (1928).—A review of the history of fused silica, the modern methods of manufacture and uses in chemistry. (*C. A.*)

Refractories: Their manufacture and applications. J. F. HYSLOP. *World Power*, **10**, 137–44, 256–78 (1928).—Survey of the characteristics of the chief refractory materials, silica and silica-alumina, illustrating the main factors which determine their service behavior and use: strength, effect of temperature, electric properties, etc. (*C. A.*)

The optical properties and changes in state of zircon. W. F. EPPLER. *Z. Krist.*, **64**, 510–11; *Physik. Ber.*, **8**, 734 (1927).—According to Stevanovic there are 3 kinds of zircon distinguished by density: *a* has a density of 4.0 unchanged on heating; *b* has a

constant value 4.7; *c* is unstable and goes over to *b* on heating. Densities and refractivities are now determined on 7 specimens of different colors. Hyacinth from Laacher Sea at 197° has a reversible change in *n* of 30 units in the 4th decimal place. With *c*-zircon (green from Ceylon) there is a monotropic modification change at 1950° to normal *b*-zircon. Reversible color changes were observed, the color being due to content of Si, Zn, Hf, Ti, Cu, Fe, Zn, and Ca. (*C. A.*)

Sillimanite refractories. A. E. J. VICKERS. Brit. Refract. Res. Assn., *Bull.*, No. 14; *Gas Jour.*, **178,** 997–99 (1927).—Sillimanite brick appears to be remarkably resistant to temperature, but attacked by iron oxide and iron oxide slags. In a steel furnace the bricks cracked and spalled badly. A sillimanite brick under a load of 50 lbs. per sq. in. showed uniform expansion up to a face temperature of 1280 to 1300°C. Contraction occurring during 2 hrs. heating at 1350°C was small and slow. In the case of a sillimanite brick under load, the temperature rising continuously above 1350°C, at the rate of 1 cone per minute, it was found that thermal expansion slows down at cone 7, that there is a wide range of temperature in which the under-load subsidence proceeds very slowly, and that from cone 14 to cone 27 the form of the curve is analogous to the typical load-subsidence curves shown by fire clays, and that finally complete failure occurs with extreme rapidity and without the preliminary rapid subsidence shown by fire clays. (*J.I.M.*)

Effects of firing temperature, grog kind, and grading on the properties of firebrick material. A. J. DALE. *Gas Jour.*, **178,** 999 (1927).—The commercial value of highly aluminous products made by bonding prefired "diaspore clay" with a ball clay is emphasized. "Diaspore clay" is much cheaper than sillimanite, but contains about 72% Al_2O_3. Prefired, ground, and mixed with 25% bond clay, and then fired at cone 8, "diaspore clay" yields brick having an ordinary refractoriness of over cone 35. Under a load of 50 lb. per sq. in., such brick withstands a temperature of 1710°C before failing. Tested for 2 hrs. at cone 14, these high alumina mixtures show no after-contraction. The materials are suitable for use in constructions where silica shapes are liable to spalling. (*J.I.M.*)

Load-bearing capacity of siliceous products at high temperatures. A. J. DALE. *Gas Jour.*, **178,** 999 (1927).—The chemical composition of refractory materials containing 75–92% of silica is of subsidiary importance at high temperatures compared with that of physical composition. Grain-size of the quartzitic particles has considerable effect on behavior under load at high temperatures. When an excess of large (4- to 8-mesh) quartzitic granules is present, premature failure is likely to occur in the high-temperature load test. Although commercial siliceous refractory may fail at a comparatively low temperature (1500°C) under a load of 50 lb. per sq. in., it may be specially rigid under lower loadings at 1400°C or at even higher temperatures. The incipient conversion of quartzitic particles which begins at about 1250°C causes a tendency to disrupture, flaking, etc., under high stress. (*J.I.M.*)

Properties of quartz-clay mixtures. A. J. DALE. *Gas Jour.*, **178,** 999 (1927).—The load-bearing capacity and thermal expansion characteristics of mixtures of finely ground quartzite with a Stourbridge fire clay have been investigated. So far as the temperature of initial deformation under low load is concerned, mixtures containing 15 to 30% of finely ground quartzite, fired at cone 8, commence to deform at temperatures 100°C lower than mixtures containing 30 to 60% of artificially added quartzite. The greater the amount of unconverted quartz in a fire brick after kiln firing, the greater the effect of load on the temperature at which disrupture under load commences when the rate of rise of temperature is rapid. After normal kiln firing at cone 8, rapid thermal expansions were recorded at 95 to 195°C, 195 to 295°C, and 545 to 645°C. After repeated refiring at 1350°C, the quartzitic expansion (545 to 645°C) had practically disappeared, but the tridymitic expansion (95 to 195°C) had almost doubled. From the point of view

of spalling, the temperature range below 200°C is dangerous. The least refractory mixture at moderate temperatures is by no means the least refractory at higher temperatures. (*J.I.M.*)

Silica and magnesite bricks in metallurgical furnaces. GERHARD WOLFF. *Met. Ind.*, (London), **32,** 177–78, 183, 236–37 (1928).—The requirements for refractories for metallurgical furnaces are: (1) high softening and melting points; (2) resistance to fluctuations of temperature; (3) chemical and physical inertness; (4) small changes in shape and volume; (5) mechanical strength; (6) high or low thermal conductivity, according to circumstances; (7) durability; (8) uniform composition; (9) perfect workability. The degree of which various refractories in common use fulfill these requirements is discussed, and a full comparison is made between the suitability of silica and of magnesia bricks. (*J.I.M.*)

Methods of testing the raw materials for refractory products. W. MIEHR. *Z. tech. Physik*, **8,** 101–109 (1927).—A general survey of methods of testing refractory clays, kaolin, and quartzite used in the Centrallaboratorium und Forschungsinstitut des Didier-Concerns, Stettin. Besides the usual physical, mechanical, chemical, and microscope tests, X-ray examinations are made to determine the individual constituents. (*J.I.M.*)

New processes for the improvement of refractories and for protection against soot. M. SEILLAN. *Chal. et Ind.*, **9,** 152–53 (1928).—Neutron and Capol, both colloidal solutions of graphite, are proprietary articles intended for protecting the surfaces of furnaces. The former is applied by painting, cement gun, or other means to the refractories to prevent their destruction by slags or other agents; the latter is intended to facilitate the removal of soot from boiler tubes. (*J.I.S.I.*)

The selection and use of refractories for iron foundries. C. PRESSWOOD. *Foundry Trade Jour.*, **38,** 43–47 (1928).—The selection and use of refractory materials for foundries are considered, and desirable properties are discussed. (*J.I.S.I.*)

Refractory natural stone for lining cupolas and converters. O. BECKMANN. *Giesserei-Ztg.*, **25,** 156–59 (1928). (*J.I.S.I.*)

A machine for dressing fire brick. ANON. *Iron and Coal Trades Rev.*, **116,** 424 (1928).—Brief particulars are given of a machine in which fire brick can be dressed to the required size, squared off, bevelled, and their surfaces smoothed with great precision. (*J.I.S.I.*)

Important properties and requirements of some special refractories. M. F. BEECHER. *Trans. Amer. Soc. Steel Treating*, **13,** 473–84 (1928).—The properties of mullite, fused alumina, and silicon carbide are outlined. The common causes of failure in refractories are also pointed out. (*J.I.S.I.*)

PATENTS

Method of making aluminum sulphate. ROY MACKAY MEIKLEJOHN. U. S. 1,679,366, Aug. 7, 1928. In the art of making aluminum sulphate, the improvement which comprises causing reaction between an alumina-bearing material and sulphuric acid of such strength that substantially complete decomposition is effected and that the resulting product is basic, and establishing and maintaining a temperature of approximately 178°C throughout the reaction to preserve a liquid state in the reacting materials.

Process for obtaining pure alumina and alkali-metal carbonates. FRITZ ROTHE AND HANS BRENEK. U. S. 1,680,066, Aug. 7, 1928. The process which consists in mixing minerals containing alumina with an alkali-metal sulphate and heating the mixture to incandescence in the presence of steam at a temperature of at least 1100°C avoiding any reduction in the mixture during the process.

Electric furnace for producing silicon carbide. HAROLD E. WHITE. U. S. 1,684,611, Sept. 18, 1928. An electric furnace of the character described, comprising a hearth,

spaced concrete supports for the hearth, and concrete end walls for the furnace free of fixed connection to the hearth supports.

Manufacture of zircon refractories. LE ROY HIMES MINTON. U. S. 1,684,739, Sept. 18, 1928. The method of making zircon refractories which comprises finely grinding zircon in the presence of water containing an organic deflocculent, adding granular zircon and an organic binder, and shaping and firing the resultant product.

Masonry arch for high-temperature use. FREDERICK HARWOOD NORTON. U. S. 1,686,761, Oct. 9, 1928. A furnace roof of refractory material for use under high temperature conditions, composed of two sections, each of which is free to move as a unit when heated, and being of substantially an inverted catenary shape and supported only at its edges.

Checkerwork for open-hearth and blast furnaces. FRED H. LOFTUS. U. S. 1,686,826, Oct. 9, 1928. In a checker chamber for reverberatory furnaces, parallel spaced vertical walls reaching across the chamber and extending from the top to the bottom to form narrow elongated wells separated one from another, and a plurality of spaced rows of super-imposed fixed heat exchangers rigidly mounted in the walls and extending across the wells, the exchangers in one row being in staggered relation to the next adjacent row forming a plurality of fixed uniform intake and discharge passages throughout the wells and adapted to afford a fixed predetermined minor resistance to the passage of the gas through the wells in one direction and upon reversal of the furnace a fixed predetermined major resistance in the opposite direction.

Method of manufacturing magnesite brick. BERRY MARVEL O'HARRA. U. S. 1,686,876, Oct. 9, 1928. Process of manufacturing magnesite brick which consists in crushing calcined magnesite into small particles, mixing with water containing magnesium chloride in amount equivalent to 5 to 10% of the calcined magnesite, adding to the mixture an aqueous solution of sodium hydroxide or ammonium hydroxide in amount approximately equivalent to the magnesium chloride, thereby to form magnesium hydroxide in contact with the particles of magnesite, compressing the mixture into bricks, firing the bricks, whereby the magnesium hydroxide is converted to magnesium oxide, and continuing the firing at a higher temperature to convert the magnesium oxide into periclase.

Furnace wall. NATHAN E. LEWIS AND HOWARD J. KERR. U. S. 1,686,976, Oct. 9, 1928. In a furnace for a steam boiler, a relatively fixed wall and an auxiliary wall extending upwardly from the fixed wall and inclined to the vertical with its top substantially horizontal, the auxiliary wall comprising a series of metallic supports extending upwardly along the auxiliary wall and tile attached to the supports with the tile between the furnace and the supports, the tile being free to move longitudinally of the supports with the lowermost tile abutting against the fixed wall.

Refractory substances. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 294,179, Sept. 12, 1928. In the manufacture of refractory products from bauxite, the alumina is caused to crystallize by the addition of catalysts such as fluorides or fluosilicates preferably of alkalis or alkaline earths. Raw bauxite intimately mixed with 0.5 to 2% of fluoride or fluosilicate is calcined and ground, and then mixed in a moistened state with raw materials such as bauxite or refractory clay and an equivalent quantity of fluoride or fluosilicate. The whole is molded and fired to give the finished product.

Refractory substances. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 294,552, Sept. 19, 1928. Refractory substances of high thermal conductivity for lining vessels are made with a high proportion of silicon, pure or ferrous. For example, 95 parts of finely ground silicon is mixed with 5 parts of milk of lime and fired. The composition may contain sand or clay and fluxes such as feldspar, cryolite, waterglass, etc. By a proper

choice of the binding and fluxing materials the product is obtained acid-proof, and by firing above 1200°C, it is rendered alkali-proof.

Refractory brick. Soc. Lorraine des Acieries de Rombas. Brit. 295,051, Sept. 26, 1928. Brick for use in metal furnaces is made from a dampened mixture of blast-furnace mouth dust, coke dust, and ferrous flux by means of an ordinary press, and fired in a kiln of the kind used for clay brick. The ferrous flux consists of ashes containing oxides, preferably ferrous oxide.

Terra Cotta

Testing crazing of ceramic glazes. H. G. Schurecht. *Pottery Gaz.*, **53** [616], 1628 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [5], 271–77 (1928); see also *Ceram. Abs.*, **7** [6], 378 (1928). E.J.V.

Modern structural ceramics in Berlin. Otto Riedrich. *Keram. Rund.*, **36**, 371–74 (1928).—Modern Berlin buildings in which brick, tile, and terra cotta are used for structural and ornamental purposes are described and illustrated. H.I.

White Wares

Transportation problems. G. Helm. *Ber. deut. keram. Ges.*, **9** [8], 465–76 (1928).—Investigations in whiteware and porcelain factories show the importance of transportation. Methods of drying and the large number of molds necessitate transportation. Modern conveying means release the highly paid operators, which are thereby removed to productive labor. F.P.H.

Effect of the particle size of quartz upon the properties of whiteware bodies. H. Harkort. *Ber. deut. keram. Ges.*, **9** [8], 476–89 (1928).—Seger recommended a decrease in particle size of quartz in the body to eliminate glaze cracks in stoneware. H. Kohl showed that expansion coefficients of a body rich in quartz between 10 and 500° can be increased about 50% by finer grinding. W. Steger confirms this but gives no numerical data on particle size of the quartz and the change produced by grinding. If particle size of quartz is so effective, it is important to investigate the several physical properties in relation to systematically varied particle sizes of quartz. With the improved Schulze elutriator several fractions were made as follows:

Classification	Particle size	Elutriatable with velocity
Coarser sand	$\infty - 0.015$ mm.	
Fine sand	0.015–0.008 mm.	0.10 mm./sec.
Very finest sand	0.008–0	0.03 mm./sec.

Two facts were obtained: (1) firing quartz-clay kernels at cone 1 insures against glaze cracks and (2) coarse quartz grains will cause glaze cracking on bodies fired to cone 6. Coarse quartz cannot fully exert its contraction and expansion upon the clay or the decomposition products of the clay surrounding it. But the quartz will do this, the more finely it is divided and the more densely the clay is incorporated with it, and the more intimately the two are mixed. Therefore with increasing heat treatment there is a consolidation, and crowding together of the clay and quartz. Small amounts of alkali, iron oxide, and lime accelerate the influence of quartz on the coefficient of expansion. Whether one is satisfied with this mechanical interpretation, or credits reactions within the quartz kernels (which previous microscopic research has not indicated), its presence affects the thermal behavior of clays and bodies. F.P.H.

Raw glazes. H. Bollenbach. *Ber deut. keram. Ges.*, **9** [8], 495–99 (1928).—B. describes the different kinds of glazes, their compositions, uses, advantages, and disadvantages. Nearly all stoneware and faience glazes consist for the most part of frits. Glaze for stoneware is therefore more complicated and more expensive than for porcelain. Lead-containing, and to an even greater extent lead-free glazes for low temperatures are

extraordinarily sensitive to the sulphuric acid of the firing gases. This trouble is encountered up to cone 2 even in a wood fire. Raw glazes with calcium borate remain free from sulphuring. The cause of this insensitivity to sulphuric acid and vapors cannot yet be satisfactorily explained. We have, however, established this fact in numerous firings. Calcium borate here acts therefore in apparently the same way as the addition of unfritted lead carbonate which was recommended by Berdel for this purpose. It cannot however be used in lead-free glazes. Boric acid may have an effect other than increasing the luster of glazes. It may also cause the glazes to become turbid. Seger and Berdel repeatedly call attention to this phenomenon. We have produced glazes for structural ceramic purposes and also for faiences which are zinc-free, but show turbidity. Such turbidity is only otherwise obtained by the addition of 10% zinc oxide. Our glaze contains only 0.6 mol B_2O_3 for SiO_2 content of 1.2–1.5 mol and 0.2 mol Al_2O_3. In addition to lime and potash, magnesia and zinc oxide are also used as bases. The firing temperature is cone 05. The advantages of the calcium borate glazes are summarized: (1) the fritting process and the fritting kiln are eliminated; (2) time of grinding is shorter than in the case of frits; (3) glazes are stronger since they are specifically lighter; (4) calcium borate is cheaper than lead; (5) glazes may be applied better; (6) it is not necessary to keep large amounts of glaze frits on hand and invest capital in them.

F.P.H.

Development of porcelain insulator design since 1858. ANON. *Ceram. Ind.*, **11** [4], 357–61 (1928).—The high-voltage insulators must undergo tests for electrical and mechanical resistance. Fundamentally there are two differing electrical testing methods. These are the individual or mass test which must be applied to each insulator for determining possible defects; and the form or type test for determining up to what voltage the insulator can be used in transmission services, or what safety it assures. The first test method is illustrated. Several hundred insulators are placed at the same time in a water bath; the centers of the insulators are filled with water; the electrodes thus formed are then connected to the high-voltage terminals of a transformer of sufficient capacity, of 20,000 to 100,000 volts or more. The voltage is then increased to the limit of the surface-insulation resistance of the insulators and kept constant for at least 15 minutes, during which any defective insulators are surely detected. Besides this alternating-current test, the electric-tension shock test has gained increasing importance. In this test the highest applicable voltage is applied to the insulator for a short period; perhaps about 1/100,000 of that used with an ordinary alternating current. A much higher voltage may be used in this test because there is not sufficient time in the short period for the air surrounding the insulator to become ozonized and thus complete a circuit. For these particular tests various circuits can be used, by the aid of which the surface voltage can be increased to 1.5 to 2.5 times the alternating-current surface voltage. For example, by means of a rotating rectifier the alternating voltage may be changed into pulsating direct voltage, with which two condensers are charged. If the voltage is increased until a spark is pronounced at the spark gap, a voltage shock develops in the insulator to be tested; this shock has nearly as high a voltage as existed in the extremities of the condensers. This voltage can be measured with a special measuring spark gap. There are some difficulties connected with this testing method, which can be overcome by varying circuits somewhat. The high-voltage insulator is also tested with the high-frequency equipment. In this test the discharge voltage varies greatly; under some conditions it is lower than the operating frequency of 50 cycles per second, depending on the degree of coupling and the dampening of the vibrations. In the shock test and even more in the frequency test the discharge passed over the surface of the insulator and in the alternating-current tests the discharge is more or less through the air. The high frequency test belongs to the second group of tests, since it is rather a form test with a surface discharge. As a rule alternating current is used at operating frequency.

Weather conditions are made artificially in order to perform a thorough test for electrical surface resistance. The tests must be performed with all possible kinds of weather and rain conditions. Among the many methods devised for the scientific testing of insulators is that of determining the electrical field around an insulator by means of the so-called straw test. This test was specified by Toepler, of Dresden, and further developed in the porcelain works of the Hermsdorf-Schomburg-Isolatoren G.m.b.H. An easily moving pointer, whose guiding pin is suspended between two silk threads is brought into the electrical field which is to be tested; the pointer will then move in the direction of the field. In order to record this movement, a projecting camera is used to throw the shadow of the pointer on a white sheet of paper on which it is then traced with a pencil. The equipment for this test is shown. If then by the use of a glimmering tube the strength of the field is determined, one may determine the distribution of the voltage over the various parts of the insulator or the parts of a chain of suspension insulators by means of the integration of the field curves between the two equi-potential surfaces. It is shown for example in what way the voltage of a ten-link chain, expressed in hundredths of the total voltage in the chain, is distributed. Because the insulators for overhead transmission lines must meet heavy mechanical requirements, the mechanical test is very important. Transmission voltages are constantly increasing which requires lines of greater diameter and greater weight. Wind pressure, snow, and ice must also be considered in making the mechanical tests. Formerly the specific draft resistance of porcelain was as much as 31 lb. per sq. ft.; but now the leading porcelain works obtain specific draft resistances of 82 lb. per sq. ft. or more. Pressure resistance must be considered for insulators to be used on antennæ towers, etc. The bending resistance must be considered in the wide disk type insulator, and several types of supporting insulators. In these types the porcelain body is fitted into a metal bottom cap, while the line draft is vertical to the axis or at the head of the insulator. Insulators must also be designed to resist the effect of stones thrown at them or bullets shot at them, at least sufficiently to protect their cores. Temperature changes must also be considered. The Union of German Electro-Technicians prescribes that insulators must undergo certain temperature tests in which the insulators are for a longer period exposed alternately to a hot (203°F) and to a cold (59°F) water bath without showing cracks. One of the most important requirements, however, is absolute devitrification; the porcelain must be entirely free from pores and must not absorb moisture from the air. F.P.H.

Education for merchandising ceramic ware. W. G. JACKSON. *Ceram. Ind.*, **11** [4], 364–69 (1928). F.P.H.

Collapse in plate bottoms. L. HEIN. *Keramos*, **7** [14], T5 (1928).—This undesirable pheonomenon which appears and disappears again without remedy, is a result of several causes. In correcting this trouble the following points must be considered: the mold, the body, hand mold, type of top mold, drying, saggers, weak biscuit firing, and glaze. Any one or all of these may cause the collapse of bottoms. The elimination of this defect demands time and consideration. F.P.H.

Cup manufacture. L. HEIN. *Keramos*, **7** [18–19], T12 (1928).—The cause of warping in cups is discussed. H. finds warping is due principally to unequal support in the kiln. F.P.H.

Penn Tile Works have new white clay. ANON. *Clay-Worker*, **90** [3], 191 (1928).—Penn Tile Works Co., Aspers, Pa., miners and shippers of the famous Blackbird natural black firing clay, have recently located an immense deposit of white clay, practically all of which will go through 150-mesh sieve as it comes from the earth. This clay fires a very beautiful cream. It is being put on the market in an attractive cream and ivory ceramic tile, and is also very adaptable for use in a glazed wall tile body. It is mined in immense quantities and can be furnished at low price. E.J.V.

Colored vitreous ware. ANON. *Clay-Worker*, **90** [3], 205 (1928).—Among the people making sanitary pottery, *i.e.*, vitreous china plumbing fixtures and kindred lines, there has been, as in the making of wall tile, a decided trend toward colors. Instead of seeking to make clear whiteware, various color tints have been developed and now standardization of colors is desired so that there may be harmony. A subcommittee has been appointed by the vitreous chinaware folks to consider the practicability of standardizing colors of vitreous plumbing fixtures and other bathroom specialities so that the colors made by the various groups can be harmonized and put upon a positive basis to get the best effects in finished bathrooms even though the various products used therein come from different sources. E.J.V.

Effect of lepidolite in a high-tension electrical porcelain body. R. TWELLS. *Pottery Gaz.*, **53** [616], 1637 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [8], 644–48 (1928); see also *Ceram. Abs.*, **7** [9], 624 (1928). E.J.V.

Cements for china and porcelain. ANON. *Pottery Gaz.*, **53** [616], 1637 (1928); reprinted from *Seifensieder Ztg.*—There are numerous recipes already known for cementing porcelain, china, and similar ware, but few of them are really good, and the recipes are regarded as secrets by the manufacturers. The following recipe is for an unusually good cement: 14 parts white fine resin, 7 elemi resin, 7 shellac, 7 mastic, 42 sulphur are crushed into a fine powder, well mixed and melted, and 20 parts finely sifted brick-dust added. A waterglass cement for porcelain and china may be made by mixing 1 part soaked glass powder, 6 parts soaked fluorspar meal, and 6 parts waterglass solution. A very good casein cement is obtained as follows: Fill a bottle one-quarter with fresh casein and then fill up with waterglass solution, whereupon the bottle is closed and frequently shaken until almost all of the casein has been dissolved. This cement can be applied directly to the article. E.J.V.

The porcelain industry of Japan. ANON. *Keram. Rund.*, **36,** 233 (1928).—The great progress in the Japanese porcelain industry in the last 15 years is due in large part to the adoption of foreign methods of manufacture. One half of the output is exported, the greater part of the exported material going to the U. S. Porcelain for home consumption is of much poorer quality than the exported ware. The demand for Japanese porcelain abroad is due not to any superiority in quality of the ware but to the novelty of the decorations, Japanese screens often being used as motifs. The cost of labor is low but fuel is very high. E.J.V.

Testing insulators after pronounced fouling. HEINZ BECHDOLDT. *Keram. Rund.*, **36,** 241–43 (1928).—For the simulation of fouling in use of high tension insulators by rain water, fog, salt spray, chemical precipitates, and dusts, a room was constructed in which insulators could be connected with high voltage currents, and observed through windows. Water and solutions of various salts, alkalis, and acids were sprayed into the room. Deposits of metallic dusts gave a flash-over voltage of 3 to 4% of the normal value, salt deposits 10% of the normal value, soot and sulphur 10 to 15%. Cement dust caused a flash-over at 20% of the normal voltage and street dusts about 80%. The shape of the insulator affected the results considerably. H.I.

Porcelain as an industrial material. H. HANDREK. *Keram. Rund.*, **36,** 363–65, 386–88, 410–12, 429–31 (1928).—The definition, batch ingredients and a brief description of the manufacture of technical porcelain are given. Porcelain is distinguished from metallic industrial materials by (1) its resistance to attack by acids and alkalis, (2) its electrical nonconductivity, (3) its mechanical strength, especially its resistance to plastic deformation, impact resistance, compressive strength, and its resistance to failure by fatigue or aging. With porcelains composed of clay, quartz, and feldspar it is generally not possible to obtain optimum mechanical strength, electrical puncture resistance, and heat resistance with the same composition. Compositions must be selected with reference to the use to which the porcelain is to be put. The glaze provides

a smooth, hard, and dense surface which is very resistant to atmospheric agencies. Resistance to weathering increases with increase in SiO_2 and Al_2O_3. The glaze is important for its mechanical and thermal properties. Glazes which are suited to the bodies increase the mechanical strength and resistance to thermal shock, while those unsuited lower them. Suitable glazes have high tensile strength and their expansion coefficients are similar to those of the bodies with which they are used. Curves showing the effect of suitable and unsuitable glazes on modulus of elasticity, bending strength, tensile strength, and impact bending resistance are given. Average values for 30 different physical properties of porcelain, glazed and unglazed, are given. Methods of measuring these properties are described. Curves showing decrease in tensile strength, compressive strength, bending strength, and torsion strength with increase in cross-section of the porcelain and curves showing the relation of break-down resistance and puncture voltage to temperature are reproduced. H.I.

Material handling: a factor in modernization. G. L. MONTGOMERY. *Chem. Met. Eng.*, **35,** 531–32 (1928).—Contains illustration of a modern sanitary porcelain plant. M.E.M.

Specific heat of porcelain between 0 and 1625°C. F. M. JAEGER AND E. ROSENBOHM. *Rec. des trav. des Pays-Bas*, **47** [4], 513–57 (1928).—The principle of the metal calorimeter was employed. This method has been described by White in his publications. The calorimeter and temperature regulators are illustrated. The furnace used is completely described. The substance whose specific heat is to be determined is placed in a platinum crucible and when the desired temperature is attained the crucible and its contents are dropped into the calorimeter and the heat content of the materials thus determined. Determinations of the specific heats of platinum, tungsten, and refractory porcelain were made. The porcelains were intended for the manufacture of small crucibles for the protection of the platinum crucible when substances with corrosive properties were to be studied. The porcelains had the following compositions:

	Porcelain I	Porcelain II
SiO_2	65.14%	41.10
Al_2O_3	28.76	57.10
Fe_2O_3	1.08	0.30
K_2O	3.61	
MgO	1.21	0.50
CaO		traces

Porcelain I became soft at 1100 to 1300°C; Porcelain II had a softening point of about 1600°C. The following formulas were obtained.

(Porcelain I) $Q_0 = 0.017510t + 0.00011142t^2 - 0.000000025708t^3$

(Porcelain II) $Q_0 = 0.20698t + 0.000056155t^2 - 0.000000001895t^3$

where Q_0 is the amount of heat taken up by the one gram of the porcelain when heated from 0 to $t°$ C. By differentiation of the above formulas with respect to temperature the following formulas are obtained for the specific heats at constant pressure of the two porcelains investigated.

(Porcelain I) $C_p = 0.17510 + 0.00022284t - 0.000000077124t^2$

(Porcelain II) $C_p = 0.20698 + 0.00011231t - 0.000000005685t^2$

It was found that the specific heat at constant pressure of porcelain I (which softened at 1100 to 1300°C) reached a maximum value at about 1412°C and then started to decline. The C_p of Porcelain II showed an almost straight line when plotted against temperature. The specific heat of porcelain I varied from 0.2528 cal. per g. at 405.8°C to 0.3355 cal. per g. at 1535.5° C. The specific heat of porcelain II varied from 0.2510 cal. per g. at 395°C to 0.3809 cal. per g. at 1591°C. Values for the specific heat and atomic heat capacity of tungsten were also obtained. A.J.M.

"The family tree" of Royal Worcester. ESTHER MERRIAM AMES. *Crockery and Glass Jour.*, **106** [15], 25–27 (1928).—The Worcester factory was founded in 1751 by John Wall and William Davies, an apothecary, both from Worcester. The company included thirteen other shareholders. A history of its growth is depicted. E.P.R.

Royal Doulton, its rise and growth. ESTHER MERRIAM AMES. *Crockery and Glass Jour.*, **106** [14], 35–36 (1928). E.P.R

China clay preparations in England and Czechoslovakia. R. C. CALLISTER. *Jour. Council Sci. Ind. Research*, **1** [4], 242–48.—C. describes the mining and treatment of certain crude clay deposits to extract the china clay. Several general processes are used: (1) After preliminary treatment the clays are purified by electroösmosis. This treatment also serves to replace filter pressing. (2) Method of sedimentation and filter pressing. (3) Cornish method. The clay is obtained by hydraulic methods which serve to remove coarse particles by deposition. The dilute clay suspension is gradually thickened and finally dried. (*C. A.*)

BOOK

Properties of Clays. E. BUSS. Published by Tonindustrie Zeitung, Berlin (1928). Price 3.75 R.Mk.—The testing of pottery clays is a subject well covered by English and American textbooks, but readers of German may like to make comparisons with the German methods and appliances. The properties dealt with are: moisture, particle size, plasticity, tensile strength, viscosity, absorption of water, loss on drying and firing, total loss, firing color, fusibility, porosity, specific gravity, expansion, shrinkage, and refractoriness; with special notice of pyrites, carbonate of lime, soluble salts, working properties, and compressibility. Reviewed in *Pottery Gaz.*, **53** [615], 1409 (1928). E.J.V.

PATENTS

High-tension insulator. MINOR F. H. GOUVERNEUR. U. S. 1,684,441, Sept. 18, 1928. (1) In an insulator, a dielectric body and outer and inner metallic members secured thereto and each having steps including conoidal surfaces, the angle of the conoidal surfaces of the outer member with respect to the vertical being substantially less than the angle of the conoidal surfaces of the inner member with respect to the vertical. (2) In an insulator, a body of dielectric material formed with an upstanding stem and further formed with a recess in its underside, a metallic cap secured upon the stem and a metallic pin secured within the recess, the cap having its lower portion formed with successive steps including conoidal surfaces connected by other conoidal surfaces normal thereto, and the pin being formed with a plurality of steps including conoidal surfaces connected by other conoidal surfaces normal thereto, the angle of the first named conoidal surfaces of the pin being a multiple of the angle of the first named conoidal surfaces of the cap when considered with respect to the vertical.

Terminal for bushing insulators. ARTHUR O. AUSTIN. U. S. 1,685,662, Sept. 25, 1928. A dielectric bushing, a metallic fitting thereon having an opening through the fitting, a conductor extending through the bushing, contacting shoulders on the conductor and fitting to limit the outward movement of the conductor, a closure cap threaded on the conductor for drawing the contacting shoulders against each other to hold the conductor in position in the fitting, the cap engaging the fitting to close the opening through the fitting, resilient means in the cap for exerting pressure on the threaded surfaces of the cap and conductor, a lead conductor engaging the cap, a clamping member having differently acting threaded connections with the cap and lead conductor and acting to draw the cap and lead conductor into contact with each other when the clamping member is rotated in one direction, and means to lock the closure cap and lead conductor against relative rotation while the clamping member draws the lead and cap into contact.

Insulated perch for preventing bird trouble in connection with electrical transmission lines. ARTHUR O. AUSTIN. U. S. 1,685,663, Sept. 25, 1928. The combination with a support of an insulator string suspended therefrom, a conductor carried by the string, an insulator mounted on the support above the string, a perch carried by the insulator and extending therefrom substantially in the vertical plane of the conductor and means for preventing birds from resting on the support and perch adjacent the string but permitting them to rest on the perch at points more remote from the string.

Tiled wall or the like. GEORGE D. HAINES. U. S. 1,686,812, Oct. 9, 1928. A tiled wall comprising a sheet having in its face sets of continuous parallel grooves, the sets intersecting each other to define similar geometrical figures thereon, and a plurality of tiles covering the sheet and secured thereto, and having marginal members extending into the grooves.

Process of manufacturing insulator pins. ARTHUR O. AUSTIN. U. S. 1,685,833, Oct. 2, 1928. The process of manufacturing insulator pins comprising the steps of upsetting a metal bar between its ends to produce an enlargement thereon, separately forming a supporting member and applying the member to the enlargement to form a support for the pin.

Process of manufacturing insulator pins. ARTHUR O. AUSTIN. U. S. 1,685,834, Oct. 2, 1928. The process of manufacturing insulator pins, comprising the steps of deforming a bar to provide a projection thereon, placing on the bar in registration with the projection, a supporting member having an opening therein to receive the bar, and then pressing the supporting member to form the material thereof about the projection.

Equipment and Apparatus

Foundry sandblasting, a true abrasive process. FRANK G. STEINEBACH. *Abrasive Ind.*, 9 [8], 217–21 (1928).—One of the first applications of the sandblast process was in the cleaning department of a foundry and much of the development that has taken place has related to equipment for foundry work. In addition to its foundry work, use of the sandblast includes cleaning automobile bodies, buildings, and ships hulls, and the frosting of glassware. Modern sandblast equipment produces an exceedingly fine finish on either ferrous or nonferrous castings, performing the work in a remarkably short time. Sandblast equipment may be classified under two general types, namely gravity and pressure. In the gravity type machine, the sand is propelled by a jet of air which strikes the sand as it is fed downward by gravity. In the pressure type the abrasive is contained in a steel tank under pressure. The abrasive travels from the tank to the discharge nozzel under pressure, thus permitting the use of higher air pressures than in the gravity type. The various types of sandblast equipment applicable to the foundry industry are as follows: sandblast rooms, sandblast barrels, rotary sandblast tables, sandblast cabinets, and in some cases portable machines. The article discusses in some detail the modern sandblast rooms now in use in foundries throughout the world. E.P.R.

Chromium plating by electrolysis. M. J. COURNOT. *Abrasive Ind.*, 9 [8], 221–22 (1928).—A study of this process has been specially made in Germany but investigations also have been carried out recently at the Conservatoire National des Arts et Métiers, Paris. In chromium plating by electrolysis insoluble anodes of iron or lead are used. The electrolite is a solution of chromic acid of which the concentration should be about 250 g. per liter. Various salts are added to the bath, the most important being chromium sulphate. The operation necessitates intense currents and also heating the bath. The chromium plating is extremely hard, resists chemical attack, maintains a highly-polished surface, and its adherence on certain alloys is entirely satisfactory. An intense electric current ranges from 15 to 25 amperes for each square decimeter,

according to the composition of the bath and the metal on which the chromium is to be deposited; the temperature of the bath should be about 50°C. E.P.R.

Simplifying trucks. ANON. *Abrasive Ind.*, **9** [8], 223 (1928).—Manufacturers of lift trucks and skids held a conference June 12, under the auspices of the Division of Simplified Practice, Department of Commerce, for the purpose of formulating certain standards of dimension for hand and electric lift trucks. E.P.R.

Obsolete machining methods superseded by surface grinding. ANON. *Abrasive Ind.*, **9** [9], 233–36 (1928).—Surface grinding is now recognized as the most practical method known in modern production routine for finishing flat surfaces rapidly and accurately. In selecting equipment for surface grinding, the operations as performed in representative plants should be studied. Many such plants are listed and discussed. E.P.R.

Rubber belt care. W. F. SCHAPHORST. *Abrasive Ind.*, **9** [9], 252–53 (1928).—Rubber belts should receive the same care and attention that leather belts receive, except that the former do not require a dressing of any kind as do the poorer grades of the latter. E.P.R.

Exhibition of quarrying plant and machinery. ANON. *Refract. Jour.*, **3** [33], 839–41 (1928).—Exhibits at the exhibition held in Stanley Park at Blackpool, June 2 to 9, during the Annual Meeting of the Institute of Quarrying are described. E.P.R.

A super high-speed pan mill. ANON. *Refract. Jour.*, **3** [33], 849–51 (1928).—The super high-speed pan mill has recently been completed by the Brightside Foundry and Engineering Co., of Sheffield, to the order of a German firm of Refractories manufacturers. The novel nature of the mill is apparent, its diameter is 8 ft. and the rolls weigh no less than 5 T. each. They are suspended on what may be described as a new principle, and there is neither a through shaft nor a foot step. The mill is described in detail and illustrated. E.P.R.

Thomas recording calorimeter. ANON. *Nature*, **122,** 220 (1928); Fuel Research (London), *Tech. Paper*, No. 20 (1928).—The Thomas recording calorimeter was introduced by Cutler-Hammer Co., New York, and made in England by the Cambridge Instrument Co. This device keeps a continuous record of the B.t.u. content of a gas. On a gas of steady calorific value, the recorder agreed with a Boys' calorimeter to within one B.t.u. per cu. ft. When fluctuation occurs, there is a time lag especially when the fluctuations are of short duration, but in a long run this tends to smooth out the peaks and valleys and give the mean value approximately correct. The calorimeter has received the official approval of the Gas Referees. C.R.A.

Colloid mill increases capacity, improves quality, lowers costs. P. M. TRAVIS. *Chem. Met. Eng.*, **35,** 543–45 (1928).—T. insists that colloid mills do not grind; they simply deflocculate and disperse. They will not disintegrate solids. M.E.M.

Chemical control and modern grinding methods stimulate feldspar industry. F. P. KNIGHT, JR. *Chem. Met. Eng.*, **35,** 562–63 (1928).—The flow sheet of the Tenn. Mineral Products plant is shown. There are 20 mixing bins of 80-T. capacity for storage of crushed rock, and the contents of each bin is known by the analysis of a sample automatically taken while the bin is being filled. Grinding is done in 3 Hardinge mills in closed circuit with an air separator and with one small tube mill in the circuit. M.E.M.

Economical fine grinding and classification by air separators. L. H. STURTEVANT. *Chem. Met. Eng.*, **35,** 575 (1928). M.E.M.

Lighting for the inspection of polished surfaces. JAMES M. KETCH. *Trans. Illum. Eng. Soc.*, July, pp. 639–41 (1928).—The proper inspection of polished surfaces has presented difficult problems because of the regular mirrored reflections of all light sources from the surface being inspected. The new method for distinguishing between slight differences of color consists of placing the reflected surface within an illuminated

box, the sides of which are diffusing. The diffused light however is not suitable for inspection for surface irregularities. This is taken care of by the study of the images of two black bands placed so that these images are visible as the object is being withdrawn from the box. J.T.L., JR.

Polarized light apparatus for photo-elastic work. R. V. BAUD. *Instruments*, **1** [9], 393–400 (1928).—Five different designs of polarized light arrangement for photo-elastic work are outlined and the action of Nicol prisms and mica plates is described. Particular reference is given to the Coker apparatus as used in the Research Laboratory of the Westinghouse Electric and Manufacturing Company.

Transverse tests on round and square bars of gray cast iron. A. L. NORBURY. *Instruments*, **1** [9], 401–403 (1928).—This article is a reprint of a report of the British Cast Iron Research Association. It gives the results of an investigation to determine the difference in the modulus of rupture of square and round bars.

A new engine indicator. MAX HARTENHEIM. *Instruments*, **1** [9], 405–407 (1928).—This article points out certain advantages in a proposed design of an indicator recorder mechanism. The drum is replaced by a disk and the record will be in polar coördinates in place of the usual linear coördinates.

The calculagraph. H. C. DILSIZIAN. *Instruments*, **1** [9], 409–12 (1928).—The use of the calculagraph in long distance telephone work is taken up. The construction of the instrument is shown.

Industrial electric heating. K. MONKHOUSE. *Chem. and Ind.*, **47**, 976 (1928).—Analysis of $2^1/_2$ billion B.t.u. consumed in British plants in engineering works, brass foundries, ship yards, paint and soap works, potteries, and bakeries, shows that the heat produced electrically varies from 1% in potteries to $6^1/_2$% in engineering works. The general experience is that although the cost of heating by electricity is greater than by fuel, the results are so satisfactory that its use is extending. H.H.S.

The "cloudburst" hardness testing machine. E. G. HERBERT. *Engineering*, **126**, 28 (1928).—The process invented by H. consists essentially in allowing a stream of small hard steel balls to fall, in the form of rain, on to the hard surface. Any portion of the surface which has not been properly hardened will become indented. A projection microscope for measuring the diameters of the indentations accompanies the apparatus. H.H.S.

The Beggs deformeter. ANON. *Engineering*, **126**, 31–35 (1928).—An account of the apparatus devised by G. E. Beggs, of Princeton, to measure deformation under stress, and hence to deduce the stress. The apparatus has been used in Europe and America, especially for finding redundant arches and redundancy generally. H.H.S.

Hardness testing. G. A. HANKINS. *Engineering*, **126**, 35 (1928).—The hardness test research committee of the Inst. Mech. Engineers has now been dissolved, and H. is preparing a synopsis of all the work done in this field since the publication of the bibliography in 1916. More than 200 papers have been published on methods and machines during the last ten years. H. has further been investigating the complex relations between the mean stresses occurring in a tensile test piece during the drawing-down stages prior to fracture and the stresses deduced from indentation tests. His formula, neglecting friction, is $p_m = 2\ K \times$ a constant, where K is the sheer stress at deformation, and p_m the mean normal pressure over the cone indentation area. H.H.S.

Humidity frames, automatic and electrically controlled. G. W. GROFF. *Science*, **68**, 185 (1928).—The devices of Wm. A. Spinks of Duarte, Calif., and of H. S. Frank, of the Lingnan Univ., Canton, China, are discussed. H.H.S.

Influence of stemming on the efficiency of explosives. ANON. *Z. ges. Schiess-Sprengstoffw.*, **22**, 346–48 (1927); *Rock Prod.*, **31** [19], 98 (1928).—Five different classes of explosives were tested by the Trauzl lead-block method to determine the relative

efficiency of different stemming materials. Loam was found to be equivalent to cement and both of these materials better than water, sand, or rock dust. The types of explosives tested included gelatin and kieselguhr dynamite (75%), ammonium nitrate, sodium chloride, and potassium chlorate explosives. F.P.H.

Improvement in rotary kiln. N. C. KYRIACOU. *Zement*, **17** [25], 973–75 (1928). *Rock Prod.*, **31** [20], 84 (1928).—K. attempts to improve the thermic balance of the rotary kiln by providing a swell inside at the entrance to the sintering zone of the standard rotary kiln of uniform diameter, as shown. This effects a gathering of the raw mixture and its prolonged stay in the calcining zone, an increased kinetic velocity of the combustion gases due to a decrease in the kiln cross-section area, and therefore a better thermic transmission, better calcining and ripening of the material. On the other hand, the sintering zone is kept open by the swell, thereby providing a greater volume and slower movement of the gases, which increases the radiation heat transfer. Thus the advantages of the widened sintering and calcining zones are combined in this new rotary kiln. F.P.H.

The high-frequency induction furnace for chemical preparations above 1000° (ferrous oxide). C. N. SCHUETTE AND CHAS. G. MAIER. *Trans. Amer. Electrochem. Soc.*, **54** (preprint), 13 pp. (1928).—The use of the high-frequency induction furnace for chemical preparations above 1000° involves many special problems of technic. Varieties of furnace equipment, including a simple type of vacuum furnace not hitherto described, are discussed. Some special types of crucibles, and methods of making them, are given in detail. New methods for the preparation of FeO, using the induction furnace, are described. Miscellaneous items of technic, which may be helpful to those having to prepare chemical samples above 1000°, are included. (*C. A.*)

Registering of high temperatures in industry. V. CHARLES. *Arts et Métiers*, [89], 62–75 (1928).—The range of pyrometers used in industry is from −250 to 1600°C. Fixed points on the scale are determined by the melting points of metals, alloys, and salts, of which a selection is given. There are 7 types: (1) *Electrical resistance.* The electrical resistance of a fine platinum or manganin wire is practically a constant function of the temperature between −200 and 1200°C. The wire is wound round a quartz rod and suitably protected. (2) *Thermoelectric couples.* The construction of the iron-constantan couple is described and its use explained. (3) *Absorption.* These depend on Stefan's law, whereby the energy radiated by a hot black-body varies as T^4 (absolute temperature). The Féry and Lunette pyrometers, used from 1000 to 1300°C, are described. (4) *Electrical-optical.* These depend on comparing the incandescence of a hot body with the filament of an electric lamp, the current through which is controlled; such is the Cambridge pyrometer with a range up to 3600°C. In the Wanner pyrometer, depending on Wien's law, the light from the hot body is first polarized. (5) *Purely optical.* The light from the hot body is first polarized and then passed through a quartz wedge. The thickness of the wedge required just to give extinction is a measure of the temperature, according to Biot's law. This is the principle of the Charles' pyrometer. (6) *Calorimeters.* Several are described, depending on the absorption of heat by water and measuring the rise in temperature with a thermometer. (7) *Test-pieces.* These are either of the fusible variety, *e.g.*, Seger cones, or metallic. The latter used for their specific points, phase change, recalescence, eutectics or eutectoids, and loss of magnetism. (*J.I.M.*)

Latest advances in pyrometry. HERMANN SCHMIDT. *Ber. Eisenhüttenleute: Werkstoff.*, **107**, 1–13 (1926).—The standardization of optical pyrometers by means of tungsten lamps and the determination of the emissive power of refractories, slag, and oxidized iron are described. The various measuring instruments and the influence of lens absorption are discussed. (*J.I.M.*)

Industrial measurement of high temperatures. GABRIEL BARRIÈRE. *Proc. Assn. technique de Fonderie*, **21**, 1–19 (1927).—A full discussion of the various types of pyrometers in use for industrial purposes. Illustrated. (*J.I.M.*)

Platinum/platinum-rhodium thermo-electric couples. A. SOURDILLON AND ROLET. *Rev. de Métallurgie, Mémoires*, **25**, 90–97 (1928).—Tests show clearly that gases containing sulphur bring about the rapid corrosion of platinum wires; no thermal treatment has been found capable of stopping it. Whereas metallic protection is not satisfactory, silica offers a perfect protection. A badly protected couple soon shows points of corrosion; this corrosion does not introduce errors into the measurement of temperatures, provided the whole of the corroded zone is brought to a strictly uniform temperature, a condition not usually obtained with the ordinary type of thermocouple. During the standardization of thermocouples, a test should always be made for "parasite couples." (*J.I.S.I.*)

Flue-dust recovery. H. W. C. HENDERSON. *World Power*, **9**, 284–89, 340–47 (1928).—The article describes the application of electrical flue-dust precipitation to powdered fuel installations, to blast-furnace and coke-oven plants, to the cleaning of sulphur dioxide gases in the acid industry, and to plants working in conjunction with smelting processes, alumina calcining, and cement kilns. (*J.I.S.I.*)

BOOK

Probability and Its Engineering Uses. T. C. FRY. Macmillan & Co., Ltd., London, 1928. Price 30*s*. H.H.S.

PATENTS

Screening machine. JOHN OSCAR BOWMASTER. U. S. 1,685,018, Sept. 18, 1928. A screening machine comprising a rectangular base frame, a pair of parallel vertically disposed side plates extending longitudinally of and secured at their lower edges to the side bars of the base frame, a rectangular top frame having its side bars secured to the upper edges of the side plates, the bottom frame being of greater length than the top frame and at one end projecting beyond the latter, longitudinally disposed aggregate-guiding plates connected with the upper portions of the side plates and declining inwardly, a similarly declined transversely disposed aggregate-guiding plate connected with the end bar of the top frame nearest the projecting end of the base frame, a screen movably mounted between the side plates under the aggregate-guiding plates, and vibrating means for the frame including a shaft mounted on the projecting end of the base frame.

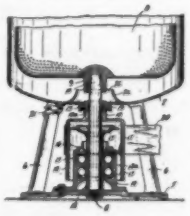
Drier. EUGENE A. HULTS. U. S. 1,685,026, Sept. 18, 1928. A drier comprising a series of compartments connected by a plurality of flues arranged to conduct heated air through the bottom of one compartment, thence upwardly through the same to the top of the next compartment in the series, thence downwardly through the same to the bottom of the next compartment in the series, and finally to the last compartment constituting the entrance compartment of the drier, the series of compartments having a plurality of tracks extending side by side therethrough and a separate flue for each track, the separate flues communicating with a single flue with means therein to force air through the flues and compartments, the compartments being separated by doors forming part of the permanent structure of the drier and through which the material to be dried may be passed from one compartment to the other, but which when closed will separate the compartments whereby air may be forced through a plurality of flues communicating with each compartment and with a common entrance flue.

Dewatering apparatus. JOHN T. HOYT. U. S. 1,685,085, Sept. 25, 1928. In a dewatering apparatus of the type described, the combination of a tank for containing the solution to be dewatered, a separating medium, comprising a smooth, fine mesh perforated plate, means to move the separating medium through the solution, means to

create a pressure differential on opposite sides of the plates to pass the water through the perforations to deposit the solid material on the exposed surface of the plate, and means to substantially completely clean the separating medium during each cycle of filter operation.

Brick mold. JOSEPH H. BECKWITH. U. S. 1,685,188, Sept. 25, 1928. (1) A brick mold comprising a bottom, side and end walls pivoted to the bottom, the end walls having their end portions overlapping the ends of the side walls and projecting transversely therefrom, the projecting end portions of the end walls being formed with recesses leading from their upper edge faces, and spring strips of greater length than the side walls secured intermediate their ends against the outer faces of the side walls and having their end portions projecting longitudinally therefrom and recessed from their under faces to provide shank portions fitting into the recesses leading from the upper edge faces of the end walls and bills to engage the outer side faces of the end walls, the extreme end portions of the strips having their under faces beveled longitudinally to form cam surfaces. (2) A brick mold comprising a bottom, side and end walls carried by the bottom, and removable partitions resting upon the bottom and extending between the side walls with their ends engaging the same, alternate partitions being provided with core members projecting from opposite sides thereof whereby bricks formed in the mold will each have one side face formed with a recess.

Bearing for centrifugal extractors. EDWARD J. ZELENKA. U. S. 1,685,347, Sept. 25, 1928. A shaft controlling device having in combination, a rotating shaft, a sleeve in which the shaft is carried having a circumferential flange between its ends, a casing in which the sleeve is disposed, a plurality of polygonal resilient members formed respectively from strips of resilient metal disposed about the sleeve in radial planes above and below the flange and between the sleeve and the walls of the casing, the members below the flange being supported by the casing, and means threaded into the top of the casing about the sleeve adapted to engage the members above the flange, the members being resilient and flexible whereby they may be flexed to be brought into contact with the sleeve, flange, casing wall and bottom of the casing.



Viscosimeter. JACQUES WOUDHUYSEN AND GASTON ORY. U. S. 1,685,896. Oct. 2, 1928. A viscosimeter comprising in combination: a cup-like container for the liquid to be tested, means for heating the liquid, a nozzle in the bottom of the container, an internal valve seat in the nozzle coöperating with a valve forming part of a tubular fitting containing a thermometer, the bulb of which contacts with the liquid to be tested, means for opening and closing the valve and a graduated testing cup receiving the liquid flowing through the nozzle.

Vibrating screen. EMIL DEISTER. U. S. 1,685,940, Oct. 2, 1928. The combination with a frame, a screening medium flexibly supported in tension on the frame, a flat elastic member rigidly secured to the frame, and extending transversely of the same, motion transmitting means secured to the elastic member and to the screening medium, and means mounted on and rigidly secured to the elastic member to vibrate the member and cause the medium to vibrate independently of the frame.

Screening mechanism. EMIL DEISTER. U. S. 1,685,942, Oct. 2, 1928. A vibrating screen comprising a main frame, a screening medium supported in tension on the frame, spring members mounted on the frame at opposite sides thereof, a transmitter member connected to each spring member and having engagement with the screening medium, a shaft revolubly supported in bearings rigidly secured to both spring members and means on the shaft to cause the spring members to vibrate as the shaft is rotated.

Apparatus for rounding up lumps of plastic material. HERBERT H. HACKSTEDDE. U. S. 1,686,853, Oct. 9, 1928. In a machine of the class described, the combination of a base having an opening therethrough and a boss depending from the base at the opening, a post rising through the boss and provided with an annular shoulder adjacent the base, a rotatable bowl concentric with the base, a sleeve depending from the bottom of the bowl and counterbored at its top and bottom, antifriction bearings between the post and the sleeve and located in the respective counterbores, a stationary member of the lower bearing lying between the shoulder of the post and the base, and means coöperating with the bottom of the post and the bottom of the boss to impinge the shoulder against the stationary bearing member to secure the post in place.

Washing sand, etc. H. S. FIELD AND J. H. HARRISON. Brit. 282,169, Feb. 8, 1928. In apparatus for separating sand, gravel, etc., from material with which it is mixed, the material, mixed with a large volume of water, and screened if necessary, is fed through a tubular inlet to a container having at the lower part an adjustable annular throat formed between an extension and a conical member which is adjustable either automatically by means of a float or by hand. An upward current of water is passed through the throat, the water being supplied through a pipe to the upper part of an elevator by which the sand is removed from the bottom of the casing. The dirty water overflows at a circular weir which is below the level of the inlet. An adjustable baffle is provided to prevent the sand from overrunning the lower part of the elevator.

Kilns, Furnaces, Fuels, and Combustion

International study of bituminous coal. ANON. *Blast Fur. Steel Plant*, **16** [9], 1199 (1928).—Twelve major topics for discussion at the Second International Conference on Bituminous Coal held under the auspices of the Carnegie Institute of Technology, Pittsburgh, Pa., November 19–24, 1928, are announced by Thomas S. Baker, president of the institution, and chairman of the congress. F.P.H.

Spontaneous heating of coal in storage. ANON. *Blast Fur. Steel Plant*, **16** [9], 1206 (1928).—The causes of heating of coal in piles is discussed. Differences in action of various kinds of coal and effect of moisture and ventilation have been studied. F.P.H.

Behavior of molybdenum as resistor in electric furnaces. H. J. MILLER AND M. LINDEMAN. *Fuels and Fur.*, **6** [3], 308 (1928).—Chemical reaction with the materials composing the furnace is the cause of the destruction of molybdenum resistors in electric furnaces. Silica and carbon are the most destructive. Directions are given for preventing this destruction. A.E.R.W.

Kiln draft in downdraft kilns. ANTON VOGT. *Clay-Worker*, **90** [3], 202 (1928).—All available draft is needed during the watersmoking process. How to determine when there is not enough draft is an important question. This is done by observing the top of the stacks. When the moisture laden vapors move slowly, the draft is sluggish and the bottom courses in a brick kiln will absorb the moisture from the top courses, and the brick will become damper than when they were set. On that account no stack, no matter how high or how big in area, will draw until the air in the stacks becomes warm. The only remedy is to heat the air by constructing a furnace at the stack with a lively fire. Use of dampers is also taken up. E.J.V.

Kiln insulation. ANTON VOGT. *Clay-Worker*, **90** [3], 206 (1928).—Due to the high cost of insulating brick, and the fact that a clay with a short firing range is very apt to overfire at the top in a kiln whose crown is covered with insulating brick, some cheaper and probably less efficient methods of insulation are discussed. These include use of a covering of hollow tile, an 8-inch layer of sandy loam, or covering the crown with hard

bats and pouring a slush made of a mixture of two barrows of sharp sand, one of screened clay, and two sacks of cement over the crown, filling the crevices between the bats.

E.J.V.

Refractories for salt-glaze kilns. W. EMERY AND A. JOHNSON. *Pottery Gaz.*, **53** [616], 1605–1607 (1928).—E. and J. describe tests made on refractory materials by building them into bag walls of a round downdraft kiln and subjecting them to a temperature of approximately 1320°C, and also the action of salt fumes. Among the results obtained was the growth of peculiar black crystals between the joints of new bag walls, when ordinary fire clay was used as jointing material. These gradually increased in size, number, and brilliancy until about the fourth firing, after which they disappeared and left a hole in the edge of the brick. A study of the analysis of these crystals showed that they approximated closely to the formula: $SiO_2 \cdot 7Al_2O_3 \cdot 2.8FeO$. A theory as to the formation of the crystals is put forward. Dealing with the fire brick used in the experiments it was considered that, apart altogether from composition, texture had an important effect upon the results. It was observed that the high alumina bricks glazed very slowly and progressively. The super-alumina types never became glossy; the color simply darkened, and at the conclusion of the tests all the brick had a deep brown-blackish color, and showed no signs of spalling or corrosion. The silica brick were satisfactory during the early stages only; after the seventh firing they began to crack, and when 10 firings had been attained the slag had attacked them vigorously; after 15 firings they had nearly all collapsed and allowed the overlying structure to fall. This exploration series of tests suggested high alumina brick would be the most economical to use, and that silica brick were of no use under "salty" conditions. E.J.V.

Fuel in the ceramic industry. ANON. *Pottery Gaz.*, **53** [616], 1628 (1928).—Among the papers presented during the Fuel Conference held in London was one entitled "Economic Utilization of Fuels in the Czechoslovakian Ceramic Industry," contributed by a Czechoslovakian committee. The ceramic industry in Czechoslovakia uses 9.2% of the country's output of brown coal and 3.4% of its total output of bituminous coal. In conjunction with the Unions of Porcelain and Glass Manufacturers, the State Institute for the economic utilization of fuels investigates experimentally the economies of fuel through its heat technology department. The paper was confined to the complete method of experimental investigation for circular kilns used in the brick and tile industry. A paper from Japan dealt with "The Application of Electricity to the Firing of Enamels on Porcelain," and stated that the cost of electricity for an electric-heated kiln, when the kwh. used at night costs 0.4*d.*, was half the cost of fuel for the wood-fired kiln. The average total cost (inclusive of the replacement of the kiln, whether for electric or wood fuel every year) of each firing, with all capital charges, not only on the kilns but on the land and buildings occupied, resulted in the wood-fired product costing double the electric-fired product. The chief technical advantages in the electrically heated kiln are: the time saved in heating up and cooling down, the complete absence of moisture in the kiln, cleanliness, and improved products. E.J.V.

The carbonization process. ANON. *Nature*, **122**, 145 (1928).—In a report by the Joint Research Committee of the Institute of Gas Engineers and the University of Leeds, the effect of the size of coal and of the addition of various inorganic substances on the coking process are discussed. The yield of gas in therms is increased by the addition of these materials. The presence of 3.3% Na_2CO_3 increased the gas yield 12%. A larger yield of ammonia was induced by the addition of $CaCO_3$. C.R.A.

Red facing brick fired with oil. The tunnel kiln in America. ANON. *Brit. Clayworker*, **37** [437], 218–20 (1928).—The use of the tunnel kiln is advocated and mention is made of the rapid progress made in accepting the tunnel kiln in the U.S. for all types of ceramic manufacturing. The Hoffman, Dressler, Harrop, Russell, E.I.C.T., and Monnier types of kilns are mentioned. A discussion of the Harrop kiln as used in the

Hydraulic Press Brick Co.'s plant at St. Louis is given and a summary of the accomplishments is given as follows: The process of manufacture used is the "semidry" formed with hydraulic pressure. Cars loaded directly at the press hold 2100 bricks and pass through the drier in 2 days and through the kiln in $3^1/_3$ days. Firing temperature is 1020°C, fuel oil consumption 35 gals. per 1000 brick, capacity of plant 245,000 bricks per week. R.A.H.

The application of liquid fuels in ceramic industry. A. POPOFF. *Sprechsaal*, **61** [11], 195–97 (1928).—The advantages of firing ceramic ware in tunnel and intermittent round kilns with fuel oil against coal or wood are given. Charts show regularity of oil firing against wood firing as found in specific installations. Temperatures used and compositions of bodies and glazes manufactured in these plants are given. R.A.H.

Application of electricity to porcelain kilns. Japanese National Fuel Committee. *Chem. and Ind.*, **47,** 976 (1928).—The cost of firing porcelain by electricity is half that of wood fuel. Other advantages are the times saved in heating and cooling, the complete absence or the control of moisture in the kiln, and cleanliness. H.H.S.

Economic use of fuels in the Czechoslovakian ceramic industry. B. HELAN. *Chem. and Ind.*, **47,** 995 (1928).—The ceramic industry in Czechoslovakia uses 9.2% of the country's output of brown coal and 3.4% of the bituminous coal. The National Institute of Fuel investigates fuel economy through its heat technology department. H. details the heat balances for circular kilns for brick and tile, and emphasizes the importance of reducing heat losses at the bottom of the kiln. H.H.S.

Firing refractory materials with oil. FRANK WEST. *Refract. Jour.*, **3** [33], 854–55 (1928).—Presented at the February meeting of the Ceramic Society at the North Staffordshire Technical College, Stoke-on-Trent. E.P.R.

Thermal insulation of kilns. C. PRESSWOOD.. *Refract. Jour.*, **3** [34], 901–902 (1928).—Firing bricks and other ware is far from an efficient process. Brickmakers are fully alive to the fact that a great amount of heat is being wasted, and are quickly adopting any economies which may be indicated by the advance of knowledge. The greatest step toward 100% efficiency was the introduction of the continuous kiln in which the waste gases from a firing chamber pass through cooler bricks before reaching the stack. The heat in fired bricks may be extracted for use in drying sheds. Still there is a wide difference between heat generated and heat used. As much as 25% of the heat generated may be lost through the walls. This loss may be reduced by thermal insulation of the kilns. This type of insulation of kilns aims at reducing the losses occurring through the walls, and it is claimed that some of the best materials will effect a reduction of 70% or a reduction of 17–18% of fuel. E.P.R.

The drying of pulverized fuels. P. ROSIN AND E. RAMMLER. *Braunkohle*, **26,** 261–68, 286–93 (1928).—The Vamico pulverizer, which effects the drying and pulverizing operations in one machine, is described. The separation of the crushed and insufficiently crushed particles is brought about by hot inert gases (furnace waste gases), which therefore dry the fuel at the same time. A cyclone separator collects the fuel powder from the gas. (*J.I.S.I.*)

Recent advances in utilization and beneficiation of coal. J. F. DANIELS. *Canadian Min. and Met. Bull.*, Feb., p. 282–87 (1928).—Some of the salient features developed by research methods in the utilization and beneficiation of coal are pointed out. (*J.I.S.I.*)

Coal-picking and conveying appliances. J. W. WARDELL. *Colliery Eng.*, **5,** 27–30 (1928).—Illustrated notes are given on the design and construction of coal-picking and conveying apparatus. (*J.I.S.I.*)

Economies of electric and fuel furnaces. C. L. IPSEN AND A. N. OTIS. *Forging, Stamping, Heat Treating*, **13,** 439–42 (1927).—A comparison of electric and fuel-fired furnaces is made from the economic viewpoint. (*J.I.S.I.*)

Pulverized fuel for collieries and industrial plants. J. BURNS. *Fuel*, **7**, 138–40 (1928).—Conditions under which pulverized fuel can be successfully applied to steam raising are discussed. A table is given showing how the exposed surface of 1 cu. in. of coal increases with fineness of grinding. If 1 cu. in. is pulverized so that it will all pass a 200-mesh sieve, it will make about 64 million particles. The average size of each particle will be a cube of about 1/400 in. side, and the total surface thus becomes 2400 sq. in. (*J.I.S.I.*)

Dry cleaning of coal for carbonization. C. H. W. HOLMES. *Gas World* (*Coking Section*), **88**, 32–39 (1928).—The subject is discussed under the following headings: classification of coking slacks; relation between density and ash content; ash content and size of particles; coals capable of giving coke with 8% ash; and sulphur reduction. The application of pneumatic separation to the preparation of coking slacks is discussed at length. (*J.I.S.I.*)

The prevention of air leaks through the masonry of boilers and furnaces. The plastic heat insulator "Seal-a-Set." J. THOMAS. *Génie civil*, **92**, 166–67 (1928).—T. discuses the ill-effects on the efficiency produced by the leakage of air into furnaces. "Seal-a-Set," which is much used in America for the prevention of these leaks, consists of a mixture of asbestos fibers and of special bitumens; it is a very adhesive paste, which is applied on the outside walls of the masonry in layers from 2 to 3 mm. thick. After two or three days it forms a sort of skin, which is perfectly air-tight and elastic. (*J.I.S.I.*)

The dry preparation of coal. H. WINKHAUS. *Glückauf*, **64**, 1–13, 41–48 (1928).—The history of the evolution of the dry cleaning of coal is related, a large number of dry cleaners are described, and their results in practice are recorded. A bibliography of 40 references, of which 37 are English, is appended. (*J.I.S.I.*)

Furnace for the simultaneous combustion of both coal-dust and gas. A. SAUERMANN. *Glückauf*, **64**, 525–31 (1928).—The combustion of coal-dust in the ordinary way necessitates the use of large and expensive combustion chambers. The combustion of the dust can, however, be accelerated by the simultaneous combustion of gas. A suitable furnace designed along these lines for use in a fire-tube boiler is described and the results of tests are tabulated. In one set of tests in which the heat content in the gas and in the coal-dust were in the proportion of 1 to 2.74, the steam production reached the high value of 34 kg. per sq. m. of heating surface. In another series where the heat content proportion was 1 to 3.82, 29 kg. per sq. mm. were obtained, and the combustion of the fuels appeared to be fairly complete. These results were improved upon by alterations to the burners and also by the introduction of means for keeping the fire tubes clean. (*J.I.S.I.*)

The combustion of powdered coal: The influence of the degree of fineness of the fuel particles. B. MOORE. *Iron and Coal Trades Rev.*, **116**, 389 (1928).—The degree of fineness of fuel particles is shown to affect considerably the rates of combustion, the ignition properties, and combustible capacities of powdered coals, and the results indicate that there is a critical temperature and a critical degree of fineness at which the combustion of the particles becomes nearly instantaneous. (*J.I.S.I.*)

The dry cleaning of coal. A. N. H. SLADE. *Iron and Coal Trades Rev.*, **116**, 567–68 (1928); *Colliery Guardian*, **136**, 1544–47 (1928).—S. gives a general review of modern types of dry cleaning plant. Factors which favor the adoption of pneumatic separation and insure good results are: (1) absence of moist fines (below $^1/_{16}$ in.) from the raw coal; (2) convenient disposal of the dust collected; (3) efficient, large-capacity, non-clogging screens; (4) absence of flat scaly refuse particles; and (5) the presence of an appreciable proportion of dry and dirty fines (below $^1/_8$ in.) in the raw coal which could be extracted before the remainder of the coal goes to an existing washing plant, and thus

lead to a considerably improved performance of the washer. With correct design supervision, spiral separators can be operated to give at one and the same time a coal containing not more than 2% of refuse and a refuse containing not more than 2% of coal, which represents exceedingly good separation. The following figures represent an actual typical test result on coal sized $^7/_8$ to $1^1/_2$ in.: percentage weight of refuse picked out of clean coal, 1.18; percentage weight of coal picked out of the refuse, 1.4. The Frazer and Yancey air-sand process will doubtless have a considerable application when the practical difficulties have been overcome. A comparison is also made of capacities, power consumption, and cost of various processes. (*J.I.S.I.*)

Electrical tar extraction by the Cottrell-Moller process. J. WEYL. *Sprechsaal*, **60**, 388–92 (1927).—An electrical tar extractor capable of treating up to 180,000 cu. m. per 24 hrs. is described. The process is carried out at a temperature (80–90°C) above the dewpoint of the gases, which results in the separation of the tar practically free from water, even when treating very moist gases, such as those from a coke-oven or from the distillation of lignite. The power required is about 1.8 kw. hr. per 1000 cu. m. at N.T.P. (*J.I.S.I.*)

Theory of heat. H. LE CHATELIER. *Trans. Amer. Soc. Steel Treating*, **13**, 555–72 (1928).—Le C. covers the problems of suitable heating; the supplying simultaneously of the required amount of heat and the temperature necessary for carrying out the contemplated action; the cost of fuel, labor, and maintenance, which is exactly proportional to the consumption of calorific energy. The author points out that there are many factors which play an important part in heat theory, *e.g.*, the transfer of heat and its utilization are controllable by the laws of energetics, also the effect of passive resistance and conditions of reversibility. The different types of perfected apparatus are explained, particularly the shaft furnace, with its current of gases, and the burning of quartz is followed through. The importance of an even distribution of temperature within the furnace and its necessary limitation as applied to the melting cupola are also dealt with. (*J.I.S.I.*)

Geology and oil and gas possibilities of the Bell Springs district, Carbon county, Wyoming. C. E. DOBBIN, H. W. HOOTS, AND C. H. DANE. U. S. Geol. Surv., *Bull.*, No. 796D, (1928). (*J.I.S.I.*)

PATENTS

Tunnel kiln, furnace, and the like. CHARLES F. GEIGER. U. S. 1,686,083, Oct. 2, 1928. The combination with a furnace having a passageway therein, of a combustion chamber movable along the passageway.

Calcining furnace. JAMES H. KNAPP. U. S. 1,686,565, Oct. 9, 1928. A calcining furnace, including a rotatable calcining drum, means for heating the same, material handling means separate from the drum but adjacent one end of the drum and substantially co-axial therewith, a packing between the material handling means and the drum, and means for maintaining a substantially uniform pressure on the packing regardless of expansion or contraction of the drum, substantially as described.

Electrically-heated kiln. GOTTLIEB KELLER. U. S. 1,687,025, Oct. 9, 1928. In apparatus of the character described, means providing a vertically-disposed heating chamber, heat-radiating elements disposed within the chamber and supported in spaced relation with respect to each other in such manner as to provide for retarded gravity-induced movement of material in the chamber, and heating means disposed within the elements and sealed thereby against direct contact with the material.

Cements; treating ores. M. GENSBAUR. Brit. 294,194, Sept. 12, 1928. Raw cement powder, either alone or mixed with fuel, is molded into pieces, bricks, or cords and is burnt in a rotary kiln. The kiln preferably has an annular enlargement at the inlet, this enlargement forming a burning pocket in which the material is temporarily

retained. Raw cement powder, with or without fuel and moistened or mixed with a binding medium, is fed from a bunker through a conveyer to a press. This press discharges the molded material into a tube which passes to the enlarged inlet of the kiln. If the material is in cord form, it breaks off, or is cut off, when it projects a certain distance from the end of the tube. The process is also applicable for the roasting, burning, agglomerating, fritting, etc. of ores and mixtures.

Geology

Geophysical prospecting methods. F. MÜLLER. *Ber. deut. keram. Ges.*, **9** [8], 499–500 (1928).—The objects and methods of applied geophysics are explained with the purpose of arriving at a quantitative understanding of the substrata. The development of the methods and instruments used has already attained a high level. Experimental material on the physical constants of the substances occurring in the earth's crust has been collected, and exact mathematical relations for numerous material, form, and force combinations have been derived. The methods are divided into (1) those which measure suggested combinations, and (2) those which because of their many possibilities of application furnish a working "illumination" of the earth under established experimental conditions. F.P.H.

Volcanic ash resources of Kansas. KENNETH K. LANDES. Kansas State Geol. Surv., *Bull.*, No. 14; *Rock Prod.*, **31** [20], 44 (1928).—Volcanic ash, according to this report, is composed of excessively fine glass or lava fragments. It is produced by volcanoes, but due to the lightness of the individual particles it may be carried by the wind many hundreds of miles from its source. Many names have been given this material. Among them are volcanic dust, pumice, pumicite, geyserite, silica, and feldspar. Because volcanic ash is not a product of combustion, a number of geologists object to the word ash. But the term predominates in literature and is defined in the dictionaries, so it is preserved. Pumice refers to larger vesicular rock-glass fragments of similar composition and origin. When ground it has properties very similar to volcanic ash. Geyserite is mineral matter deposited by geysers about their vents, and this term was applied to volcanic ash deposits in Nebraska when they were first discovered and their origin misconceived. The prevailing field term in Kansas for volcanic ash is silica. Chemically speaking, the ash is composed largely of silica, but this compound is not present as free silica, but in the form of silicates. The term feldspar has also been erroneously applied to the Kansas deposits. F.P.H.

Exploitation of high-silica rocks. P. G. H. BOSWELL. *Rock Prod.*, **31** [20], 45 (1928). —The occurrence, mining, composition, and physical properties of the following forms of silica are described: quartz, tridymite, chalcedony, tripoli powder, geyserite, ganister, and quartzite. F.P.H.

China clay industry of western England. E. H. DAVISON. *Pottery Gaz.*, **53** [616], 1622 (1928).—China-clay rock occurs in all the granite outcrops of the West of England, but the Hensbarrow district, near St. Austell, and the southern part of Dartmoor, are the areas producing the best quality of clay. It occurs as a soft, altered granite, which can be dug out with a spade, the result of the action of gases and solutions which were given off after the granite had consolidated, and which came up along fissures in the solid rock, changing the feldspar in the rock on either side to china clay. Evidence of this is (1) the china-clay rock is more completely kaolinized near the fissure lodes, "stent" lodes, and the completeness of kaolinization increases with depth; (2) the occurrence of the china clay is associated with the occurrence of such minerals as tourmaline, gilbertite, and sericitic mica; (3) the physical characters of the west of England china clay are markedly different from those of clay of obvious meteoric origin; (4) clay deposits occur with a covering of unaltered granite; (5) though clay deposits have been worked to a depth of 350 ft., no instance is known of a deposit dying out in depth. The

clay rock is sluiced with water under pressure in open pits, the sand allowed to settle out in the pit and the clay-water suspension is pumped from the pit to pass through narrow channels where the mica, coarse clay, and fine quartz settle out before the settling tanks are reached. The clay is allowed to settle out and then dried. The clay is of two qualities, (1) for paper making, filling cloth, etc., having a fine grain and pure white color, and (2) potting clay, used for porcelain making. Various details of production methods and innovations introduced in late years are discussed. Though china clay occurs in many other parts of the world, no foreign clay can at present compete with the Cornish and Devon clay, which is exported to all civilized countries. E.J.V.

Properties of clays and kaolins: use of tables for the stoneware clays of the Westerwald region. FRITZ BUSS. *Keram. Rund.*, **36,** 219–21 (1928).—B. criticizes tables of properties of German clays because the measurement of the properties listed requires elaborate and costly laboratory apparatus. A method of classifying different clays from the same deposit or from different deposits is suggested based on the screen analysis, the firing shrinkage, and the color after firing. Samples after drying at 110° are crushed in a mortar to a size of about 2 mm., placed in water for several hours and screened as a slip through a 4900 per cc. screen. The residue on this screen is dried and weighed. A sample of the same material is fired to cone 10 and the shrinkage determined. Clays from the same deposits may thereafter be identified by their similar screen analyses. H.I.

Production of fullers' earth in 1927. ANON. *Eng. and Min. Jour.*, **125** [25], 1018 (1928).—The production of fullers' earth in 1927 was 264,478 T. valued at $3,767,038. This was an increase of 13% in quantity and 12% in value as compared with 1926. Every important producing state except Ill. and Texas showed an increase. Ga. was the leading state in production, with Fla. second and Nev. third. A.J.M.

The geology of the central mineral belt of Newfoundland. A. K. SNELGROVE. *Canad. Min. and Met. Bull.*, No. 197, 1057–1127 (1928).—Metallic mineral deposits are described and useful maps are given. H.H.S.

Quantitative vs. qualitative studies in geology. G. D. HUBBARD. *Science*, **68,** 171–74 (1928).—A plea for quantitative research organized for one generation to hand on to its successors. H.H.S.

Geological and archæological records of the Yucatan peninsula. L. G. HUNTLEY. *Science*, **68,** 264–65 (1928).—A summary of work done during the past two decades by Blum, Gann, Spinden, Morley, and Gregory Mason. H.H.S.

U. S. Geological Survey: 1928 summer work. ANON. *Science*, **68,** 266–67 (1928).—The work done included study of the iron ores of the southern states, the coal fields of Mont. and N. M., phosphate deposits of Idaho, potash deposits of N. M., metallic ore surveying in several states, and the preparation of a large-scale geologic map of Texas. H.H.S.

Silica mines aid Los Angeles glass center. ANON. *Amer. Glass Rev.*, **47** [46], 16 (1928).—Early developments of new silica sand mines in Nev. will contribute materially to the prowess of Los Angeles as a glass manufacturing center on the Pacific coast. Because of its proximity to the Nevada mining field, Los Angeles has the advantage of a short railroad haul and the fact that these deposits are the largest in the U. S. There are already glass-manufacturing plants on the Pacific coast but they use Belgian sand. The Nevada sand measures up in every way to the foreign product. E.P.R.

Feldspar discovered in N. H. ANON. *Pottery, Glass, and Brass Salesman*, **38** [1], 27 (1928); for abstract see *Ceram. Abs.*, **7** [11], 784 (1928). E.P.R.

Bauxite in Morocco. ANON. *Chem. Fabr.*, Feb. 29, 1928; *Refract. Jour.*, **3** [33], 841 (1928); for abstract see *Ceram. Abs.*, **7** [8], 575 (1928). E.P.R.

Chrome industry of S. Rhodesia. ANON. *Refract. Jour.*, **3** [35], 932 (1928).—Southern Rhodesia continues to be the world's largest producer of chrome. It was not

until 1906 that a real effort was made to develop the extensive deposits of Selukwe. Each year the output grew steadily, until the total output from the principal mines has recently reached over 1,500,000 T. and is increasing yearly as the demand grows. No final estimates are available in regard to the full extent of the Selukwe deposits. From Selukwe the ore is carried over the Rhodesian railways to the port of Beira for shipment to various parts of the world. E.P.R.

The system calcium oxide, silica, and water. JOHN R. BAYLIS. *Jour. Phys. Chem.*, **32,** 1236–62 (1928).—When lime is added to a suspension of silica gel in water there appears to be formed a compound of CaO and SiO_2 corresponding to the hydrated $CaO \cdot SiO_2$. The addition of more CaO to the suspension results in the adsorption of $Ca(OH)_2$ to an extent equal to 30–45% of the lime chemically united with the silica. These conclusions are drawn from experiments in which the p_H value of the solution and the total alkalinity toward H_2SO_4 were determined after each addition of lime to the suspended gel. The points of minimum p_H and alkalinity correspond approximately to monocalcium silicate. Further addition of CaO causes these values to increase rapidly up to those at the saturation point of $Ca(OH)_2$. No evidence of compounds with a higher Ca content is shown. That the equilibrium between the solution of $Ca(OH)_2$ and the adsorbed $Ca(OH)_2$ is reversible is shown by the fact that it is approximately the same whether it is estimated by the addition or the extraction of $Ca(OH)_2$. The same type of reversible adsorption is shown when lime is added to a suspension of the diatomaceous earth "Celite." It is possible that this condition of surface equilibrium materially retards the rate of hydrolysis of some of the compounds in concrete submerged in water. According to B. the assumption of Bogue that dissociation of the Ca silicates causes the variable p_H or alkali concentration as the Ca is leached out is not correct. (*C. A.*)

BOOKS

The Central Plateau of France. HENRI BAULIG. 591 pages, 33 photographs, 11 folded sheets in pocket. Armand Colin, Paris, 1928.—Reviewed in *Science*, **68,** 255–56 (1928). B. is lecturer at the Univ. of Strassburg. H.H.S.

Geography, Geology, and Mineral Resources of Southeastern Idaho. G. R. MANSFIELD. U. S. Geol. Surv., *Prof. Paper*, No. 152. Government Printing Office, Washington, 1928. Price $2.40. H.H.S.

Silica Deposits in Western Canada. L. E. COLE. *Refract. Jour.*, **3** [35], 943 (1928); for review see *Ceram. Abs.*, **7** [9], 638 (1928). E.P.R.

Chemistry and Physics

Increase in refractoriness in ceramic bodies in interrupted heat treatment. H. B. HENDERSON AND J. H. CALDWELL. *Jour. Amer. Ceram. Soc.*, **11** [11], 795–802 (1928).—The increase in refractoriness referred to here is usually termed freezing. The study was undertaken to overcome the tendency of pyrometric cones to set or freeze when subjected to prolonged heat treatment when the temperature is more or less fluctuating. The work includes a study of the freezing tendency of some natural clays, of several pottery bodies, and of pyrometric cones. A body was developed that does not freeze under the treatment that produces the phenomenon in the other materials tested but the cause is not established.

The petrographic microscope as an instrument for the glass technologist. HERBERT INSLEY. *Jour. Amer. Ceram. Soc.*, **11** [11], 812–28 (1928).—The value of the petrographic microscope to the glass technologist in identifying crystalline defects in glass and impurities in raw materials is pointed out. The behavior of light in passing through crystalline materials and methods of manipulation of the petrographic microscope in the identification of crystalline compounds in glass and glassmaking materials are described briefly. Three colored plates are included.

X-ray investigation of the effect of heat on china clays. T. N. McVay and C. L. Thompson. *Jour. Amer. Ceram. Soc.*, **11** [11], 829–42 (1928).—X-ray diffraction patterns were obtained from an English china clay and a Georgia sedimentary kaolin, both raw and fired to various temperatures. The chief crystalline constituent of the raw clays was found to be kaolinite. Upon dehydration the kaolinite lattice was destroyed and the clays gave no diffraction pattern. Mullite was formed in both clays at 950°C and the amount increased with increase of firing temperature. In addition to the mullite, free alumina was present in the Georgia clay from 950 to 1100°C and cristobalite at temperatures above 1200°C.

Notes on Kallauner and Seger methods of rational analysis. Wilbur F. Fischer. *Jour. Amer. Ceram. Soc.*, **11** [11], 843–45 (1928).—A comparison of the Seger, Kallauner, and calculated rational analysis is made, using a Florida kaolin and a Tennessee ball clay. Results obtained are observed and discussed.

Determination of iron oxide and titania in clay refractories. W. Raymond Kerr and Edgar B. Read. *Jour. Amer. Ceram. Soc.*, **11** [11], 846–51 (1928).—Customary method of determining iron oxide and titania from ignited R_2O_3 precipitate requires considerable time. Direct titration of fusions with sodium carbonate is impossible because of gelatinous silica. Direct titration of fusions with potassium bisulphate is accurate with clays low in silica and unfired clays. By treating with hydrofluoric and sulphuric acid, and dissolving with dilute hydrochloric and precipitating the R_2O_3 by ammonium hydroxide and then fusing with potassium bisulphate the iron and titanium oxide can be titrated accurately. Method of procedure is outlined.

An investigation of the hydrometer method for determining colloid content. Paul J. Slegel. *Jour. Amer. Ceram. Soc.*, **11** [11], 852–54 (1928).—Two clays, bentonite and Florida kaolin, were used in the study of the George Bouyoucos hydrometer method for determining the colloid content in a clay suspension. It was found that the hydrometer method was not an accurate means of measuring per cent colloid, and since this method checks the heat of wetting, the latter, therefore, is also unsatisfactory.

Investigations on the one-component system SiO_2. C. J. Van Nieuwenburg and C. N. De Nooijer. *Ber. deut. keram. Ges.*, **9** [8], 491–94 (1928); *Rec. des trav. des Pays-Bas*, **47** [5], 627–34 (1928).—Certain objections have been made to the stability diagram of Fenner for the silica minerals. Some authorities believe that cristobalite is always metastable and that tridymite is the only stable solid at high temperatures. Le Chatelier states, but without conclusive evidence, that tridymite remains unaltered when heated for 2 hours at 1700°C. Rebuffat states that he found no increase in density after heating tridymite to 1650 and 1700° successively for several hours. Rees claims that the stability relations of tridymite and cristobalite are still in doubt. Alex. Scott's work seems to confirm the idea that tridymite is the stable form of silica up to at least 1550°C. The authors' opinion is that Fenner's diagram should be reconstructed. The one serious objection to Fenner's work is that it was carried out with such an excess of sodium tungstate catalyst that he, in reality, investigated a part of the ternary system SiO_2–WO_3–Na_2O and his results must be considered as a projection of a ternary system on the SiO_2-axis. If it were absolutely certain that he always reached equilibrium and that no further changes took place on cooling, no objection could be raised against this method because no homogeneous mixed crystals between SiO_2 and the other components are known. SiO_2 is appreciably soluble, however, in Na_2WO_4 at high temperatures and it is possible that the formation of cristobalite from tridymite above 1470°C is not really due to direct transformation but to a crystallization from the liquid phase. Tridymite has been changed to cristobalite without the use of flux but the transition point was not determined in this manner. The preliminary problem is to find a catalyst with a far stronger activity than that of the previously used substances. This is a problem which may be of great technical importance in the manufacture of silica bricks.

Rebuffat had stated that P_2O_5 assisted transformation. Parravano and Roselli del Turco claimed that B_2O_3 had an accelerating effect. Le Chatelier and Bogitch investigated the action of different catalyzers by measuring the decrease in specific gravity of finely powdered quartz after heating it one hour with 3% of the flux at 1400°C. They found that Li_2CO_3 and glass (composition not given) were most satisfactory but they worked with only a few substances. The authors used a much larger number of substances with a Belgian quartz which contained only about 0.04% impurities. This quartz was between 20 and 30 meshes per linear cm. in size and the work was performed at 1300°C. The quartz was mixed with 1% of catalyst and about 3 g. of it were heated in a small, unglazed, and thin-walled fire clay crucible placed on a carbon support in a carbon resistance furnace of 10 cm. internal width. The temperatures were measured with a Holburn and Kurlbaum pyrometer, calibrated on the melting points of silver and nickel. The crucible was heated for one hour at 1300°C. Then the product was crushed and washed with HCl. The specific gravity was determined in a small pycnometer with benzene as the filling liquid. It was found that Li_2CO_3, and, to nearly the same degree, Na_2CO_3 and K_2CO_3, are by far the best catalysts. It may be said that with 1% of Li_2CO_3 the inversion is practically complete in one hour at 1300°C. Fenner's catalyst (Na_2WO_4) is shown to be a very mediocre one. P_2O_5 and B_2O_3 proved to be poor catalysts. An increased amount of catalyst gave rise to a relatively small increase in the catalytic effect. As a rule, the addition of more than 1% of catalyst had hardly any additional effect. The influence of particle size of the quartz grains is very noticeable. This work only tends to show that Li_2CO_3 (and Na_2CO_3 and K_2CO_3) is an effective catalyst for the transformation of quartz into either tridymite or cristobalite. It is not at all certain that the same substance will prove to be the most efficient for the inversions of tridymite and cristobalite. It seems to be worth while to determine whether or not the addition of 0.5 to 1% of Na_2CO_3 to the bond in the raw materials for the manufacture of silica bricks accelerates the rate of inversion. A.J.M.

Analysis of chrome iron ore. ANON. *Eng. and Min. Jour.*, **125** [19], 767 (1928).—Fusion of chrome iron ore with sodium carbonate is never complete. The method recommended is to carry on the fusion with sodium peroxide in a silver crucible.

A.J.M.

Quartz for calibrating pyrometers. ANON. *Iron Age*, **122** [10], 570 (1928).—When cooling through 573.3°C, clear quartz changes its crystal lattice with liberation of so much heat that it can be used as a fixed point in pyrometer calibration. There are six reference points covering the range from liquid oxygen to the freezing point of gold. The region from steam (100°C) to silver (960.5°C) is covered by sulphur (444.6°C) and antimony (630.5°C). The temperature of quartz inversion (573.3°C) comes between the boiling point of sulphur and the freezing point of antimony. It is proposed to abandon the antimony point. The use of quartz is the most convenient and simple method for the calibration and control of thermocouples in the average laboratory. A small piece of crystalline quartz is used. If not convenient to drill a hole for the insertion of the thermocouple, the latter may be placed merely in contact with the quartz.

A.J.M.

Determination of molybdenum. H. A. DOERNER. Bur. Mines, *Information Circ.*, No. 6079, August (1928).—In describing the quantitative determination of molybdenum most texts present a method of limited application and either omit or append the precautions necessary to guard against interfering elements. For ordinary custom work it is not safe to omit the procedure for separation of vanadium and tungsten from the molybdenum unless the two elements are known to be absent. A procedure has been selected as being the simplest reliable method for such occasional determinations as are encountered in custom analysis. The complete method of procedure is given.

R.A.H.

Wave-length measurements in the arc and spark spectra of hafnium. W. F. MEGGERS. Bur. Stand., *Jour. Research*, **1** [2], 151–87 (1928).—Using the purest available samples of hafnium salts the arc and spark spectra characteristic of this element were photographed with concave grating and quartz-prism spectrographs. Wave-length measurements were made on about 2100 lines, but 609 of these were discarded as impurities, identified mainly as columbium, zirconium, and titanium. R.A.H.

Common properties of clays. G. JAKO. *Keramos*, **7** [16], T5 (1928).—It is not easy to correctly define plasticity of clay since it is a composite of numerous properties such as softening tendency, binding capacity, expansibility, stability of form, etc. One of the most correct definitions is Zschokkes' based on the rupture or deformation capacity. No satisfactory explanation has yet been found for the origin of plasticity. Fine particle size, laminated character, organic substances, humic acid, and colloidal matter favor the state of plasticity. These assumptions cannot be accepted without reservation. That plasticity increases when the attractive force between the individual clay particles is increased is probably correct, yet not attained by fine grinding. Aleksiejeff and Cremiatschensky have shown that a mixture of coarse and fine grains is most favorable. Plasticity depends on a structure which permits the clay particles to lie closely together. Laminated clay particles appear more favorable to plasticity than the spherical. Water forces clay particles apart more easily when intermediate spaces are not present. F.P.H.

Common properties of clays. G. JAKO. *Keramos*, **7** [18–19], T5 (1928).—An elementary description is given of the drying, firing, and vitrifying properties of clays and the factors which are effective. F.P.H.

Plasticity. R. JAEGER. *Keramos*, **7** [18–19], T11 (1928).—Plasticity does not appear to increase with the degree of dispersion of the particles. It is much more probable that the state in which the system finds itself is determinative for the value of the plasticity. The concentration of hydrogen ions and several other cations (Ca, Mg, Ba, etc.) exerts an important effect upon the plasticity. The plasticity will then be best when the entire clay ball in its structure can be considered a single large secondary particle. Especially great care must be exercised in the determination of particle sizes. It is important to state whether primary or secondary particles were measured, and also under all conditions to use the same dispersion medium for the measurement as for the manufacture. Plasticity is therefore not the result of the presence of a plastic acting clay, but is conditioned by the above mentioned state of the entire system. F.P.H.

Determining calcium carbonate in cement mix. FRANZ KUBIK. *Tonind. Ztg.*, **52**, 677 (1928); *Rock Prod.*, **31** [19], 98–99 (1928). F.P.H.

X-ray furnace for investigations at high temperatures and preliminary results for pentaerythritol and quartz. W. M. COHN. *Zeit. f. Physik*, **50**, 123, (1928).—An X-ray camera has been developed for the X-ray examination of the fine structure behavior of solid bodies, which do not conduct electricity, on heating. A preparation may be placed in this camera at a high temperature and kept there for a long time. This X-ray furnace is so arranged that either several exposures of the same preparation (especially rotating crystal and powder exposures) on the same film at different temperatures may be made or different films may be used for different temperatures. The changing of films may take place without change of the preparation after it has once been placed in the camera. Some preliminary results for pentaerythritol and quartz are contributed as examples for investigations at higher temperatures. F.P.H.

Specific heats of salt solutions. ZWICKY. *Nature*, **122**, 74 (1928).—At room temperature electrolytic solutions have an abnormally small heat capacity. To explain this, Z. advances the theory that in the vicinity of each ion a very high pressure is set up due to the attraction exerted by the ionic field on the dipoles of the water molecules.

An increase of pressure at room temperature decreases the specific heat of water. The theory has not yet been successfully checked experimentally. C.R.A.

The plasticity of clay. L. E. JENKS. *Pottery Gaz.*, **53** [616], 1637 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [5], 317–22 (1928); see also *Ceram. Abs.*, **7** [6], 403 (1928). E.J.V.

Vitrification of ceramic bodies. ANON. *Pottery Gaz.*, **53** [616], 1637–38 (1928).—An investigation is being made of the boundary of the field of mullite in the K_2O–Al_2O_3–SiO_2 system. As far as possible, minerals are being used in making the melts. The general procedure has been to mix the proper proportions of minerals with dextrin, making a paste which is forced through a glass tube drawn down at one end to about 2 mm. diameter. This is melted in an oxygas flame and the beads quenched in water or mercury. The melt is examined microscopically for a crystal phase and the index of the glass is measured. The results are then plotted on a 3-component diagram. Melts containing varying amounts of orthoclase, kaolin, and flint (silica) were first made and examined. Mullite crystals were found to occur in melts containing at least 30% kaolin, those with less being composed almost entirely of glass. There is an almost constant variation in the indices of the glasses, ranging from 1.48 with 10% kaolin to 1.54 with 90%. The amount of mullite crystals increases with the index of the glass. The crystals occur as fibers showing positive elongation; indices are: $\omega = 1.64$, $\epsilon = 1.66$. Leucite-kaolin melts show practically the same results as orthoclase-kaolin melts. Mullite and alumina have been used with orthoclase and leucite. The primary mullite crystals appear in all the melts containing up to 90% mullite under experimental conditions. When alumina is introduced, the mullite crystals appear in the melts containing as much as 50%. The appearance of β-corundum near the alumina end of the diagram is very interesting. An effort is now being made to make a composition of material corresponding to kaliophilite K_2O–Al_2O_3–$2SiO_2$, to be used with kaolin, mullite, and alumina in locating the extent of the mullite fields in that direction, though as yet the extreme volatility and solubility of potash have prevented success. No detailed work has been done along the boundary lines, as a reconnaissance of the whole field is first being made. Temporary factors, as well as volatilization, will probably have to be taken into account in later work. E.J.V.

Facts about ground quartz. RUDOLF JUCH. *Keram. Rund.*, **36**, 406–409 (1928).—Rapid, simple plant methods for determining fineness, presence of Fe and other impurities, and whiteness of ground quartz are reviewed. H.I.

Tribo-electricity and friction. II. Glass and solid elements. P. E. SHAW AND C. S. JEX. *Proc. Roy. Soc.* (London), **118 (A)** [A779], 97–107 (1928).—Variously prepared glass rods were rubbed by various solid elements in an apparatus designed to give constant conditions of pressure and surface. Curves are given showing the resultant charges. Some elements never, with any type of glass surface tried, showed negative charge. These were C, Cd, Fe, Pb, Bi, Ag, Cu, Au, Pt, Mg, and W. Other elements showed ultimate negative charge. These were Zn, Sn, Al, Sb, Ni, Co, Se, Te, As, Cr, Tl, and S. Evidence is given of the predominating influence on the charging of residual acid, alkali, or water films on the glass. Rubbing *in vacuo* yields results similar to those found in the open air, at least in the typical cases tried. An attempt is made to apportion to each recognized source of charge, its own weight in the various experiments. H.I.

Studies in adhesion. II. W. HARDY AND M. NOTTAGE. *Proc. Roy. Soc.* (London) **118 (A)** [A779], 209–29 (1928).—The adhesion of and tangential pull required to slide a cylinder attached to a glass plate by a solid joint are described. The joint was formed by running fluid lubricant between the cylinder and plate and freezing it *in situ*. The disk of lubricant was found to be composed of a plate of crystals with an adsorbed layer

on each side. The relation of the value observed to the temperature, pressure, chemical composition of the lubricant, and composition of cylinder and plate is discussed.
H.I.

Large scale titanium pigment production based on old laboratory process. B. K. BROWN. *Chem. Met. Eng.*, **35,** 427–28 (1928).—The Commercial Pigment Co. is now producing 10 T. daily of titania, with 40 T. of ferrous sulphate as by-product, using the Blumenfeld process. Ilmenite ($FeO \cdot TiO_2$) is treated with 60% sulphuric acid, and the resultant product leached with water, a solution of iron and titanium sulphates being obtained. The ferrous sulphate is crystallized out by cooling, after which the solution is hydrolyzed to precipitate titania. The method of hydrolysis is covered by patents. The product obtained contains less than 0.005% iron, and has an oil absorption of 25.
M.E.M.

Determination of small amounts of carbonate. W. H. J. VERNON AND L. WHITBY. *Chem. and Ind.*, **47T,** 255–59 (1928).—An accurate estimation of CO_2 without contamination by HCl or H_2S in the customary absorption apparatus is obtained by absorbing the HCl in paranitrosodimethylaniline and the H_2S by copper powder. Phosphoric acid is preferred to sulphuric for liberating the CO_2 from the carbonate, because of the oxidizing action of H_2SO_4 on organic matter. H.H.S.

Research and the training of a researcher. T. H. EATON. *Science*, **67,** 619–20 (1928).—The distinction between the carrying-on of research and the production of a man competent to do research is stressed. The functions of research and of training in research may be coördinate, but they are not coincident. E. urges scientists and universities to recognize this distinction, and to make two categories, one of which he calls university research, and the other student research. H.H.S.

Chinese National Research Institute. CHI LI. *Science*, **68,** 176 (1928).—The founding of this institute, modelled on the Smithsonian Institution, was one of the first acts of the new Nationalist Government in China. The most productive native institution hitherto has been the Geological Survey of China, organized about 12 years ago; its reports are internationally known. The membership of the National Institute includes 30 well-known scientific men. H.H.S.

Rapid colorimetric methods of p_H determination. O. W. RICHARDS. *Science*, **68,** 185 (1928).—The chief difficulty of the colorimetric p_H test is that of obtaining uniform small samples. A capillary tube is therefore fitted with a rubber cap to deliver a drop of uniform size, and pure white vaseline is spread on a plate or paper. The combined drops of standard and indicator stand up like colored beads on the greased surface.
H.H.S.

Color disks in soil analysis. DOROTHY NICKERSON. *Science*, **68,** 304–305 (1928).—Advocates the Munsell system and notation. H.H.S.

Decomposition of the calcium carbonate in ceramic pastes. MAURIZIO KORACH. *Atti congresso naz. chim. pura applicata*, **2,** 810–16 (1926).—A review and discussion of the formation of craters in ceramic ware owing to the dissociation of pockets of $CaCO_3$.
(*C. A.*)

Tables for the calculation of rock analyses. D. J. MAHONY. *Bull. Geol. Survey Vict.*, 51 (1927); *Australian Sci. Abs.*, **7,** 5 (1928).—Three sets of tables are given, based on accurate atomic weights. The first 2 tables are for molecular proportions and percentage weights of molecular proportions of normative minerals. These tables are set out in a new form which greatly shortens them, does away with interpolation, and gives accurate results to the second decimal place. The third set of tables enables practically all the common rock-forming minerals to be calculated directly from analysis and may be used for taking out both norm and mode. (*C. A.*)

Kaolin content of clays. H. BOEGE. *Chem. Erde*, **3,** 341–69 (1927).—Chemical analyses are given of eight clays from German localities. By digesting the material

in HCl (density 1.1) for 2 hrs. from 6.00 to 14.08% $Al_2O_3+Fe_2O_3$ passed into solution, this represented the colloidal portion of the Al silicate. After ignition of the material at 700° HCl extracted more (up to 36.82%) Al_2O_3, the additional amount representing the brokendown kaolin. From these results the amount of kaolin in the clay can be calculated. The amount of kaolin present in each of these clays was also determined by the dehydration method of Calsow. (*C. A.*)

Mineralogical constitution of clays. G. LINCK. *Chem. Erde*, **3**, 370–74 (1927).—Remarks on the paper by Boege (preceding abstract). (*C. A.*)

Standards of length, weight, and volume in the U. S. W. A. NOYES. *Jour. Chem. Education*, **5** [5], 586–88 (1928). (*C. A.*)

The thermal and electrical conductivity of fused quartz as a function of temperature. HERMAN E. SEEMANN. *Phys. Rev.*, **31**, 119–29 (1928).—The thermal conductivity as a function of the temperature has been determined for clear fused quartz by a radial flow method from 235°K. to 1225°K. The specimen was in the form of a hollow cylinder closed hemispherically at one end. Energy to maintain a steady temperature gradient was supplied by means of an electrically heated filament mounted axially inside the specimen. Thermal contact with the specimen was made with Hg inside and outside at the lower temperatures and with the Sn-Pb eutectic at higher temperatures. Inside and outside temperatures were obtained with thermocouples. A guard-ring scheme was used to prevent heat loss or gain at the open end of the cylinder and correction was made for the heat flow through the hemispherical end cap. The results may be represented by the linear equation: $K=3.83\times10^{-4}T+0.00163$. An abrupt change in the thermal conductivity was noted in the vicinity of 1140°K. which is attributed to heat treatment, *i.e.*, annealing or partial crystallization. An attempt was made to measure the specific electric resistance as a function of the temperature by the same method at the same time. The results were not conclusive because of the small number of data taken but there is every reason to believe that the method would be entirely successful for the determination of both quantities. The specific resistance was measured for a small piece of the original specimen. The modified Königsberger formula was verified, *i.e.*, $\rho=A\epsilon(Q/RT+aT)\rho=A\epsilon(Q/RT+aT)$. The results indicate the presence of both electrolytic and dielectric polarization. Certain peculiarities in the polarization were noted at about 1140°K. as well as a general change in the resistance-temperature curve due to heat treatment. The interpolated results are:

Temp. °K.	550	750	950	1150
Sp. resistance	4.46×10^9	2.09×10^7	1.35×10^6	2.89×10^5

(*C. A.*)

Measurement of the electrical resistance of porous materials. A. E. KNOWLER. *Proc. Physical Soc.*, **40**, 37–40 (1928).—The resistance of a specimen of refractory material is determined by passing a known current through and measuring the potential between two wires inserted in it a known distance apart. The method avoids errors due to contact resistances. (*C. A.*)

The equilibrium diagram of the aluminum-calcium system. KANJI MATSUYAMA. *Science Repts. Tôhoku Imp. Univ.*, **17** [4], 783–89 (1928).—Thermal analyses were made on 10-g. samples of Ca-Al alloys heated and cooled *in vacuo*, and changes in electric resistance with varying temperature were also measured. Photomicrographs are shown of typical alloys etched with 10% KOH, and an equilibrium diagram of the complete series is given. The liquidus shows a maximum at 1079° with 42.5% Ca, the composition of $CaAl_2$. A eutectic between the solid solution of Ca in Al and $CaAl_2$ occurs at 7.55% Ca and 616°, and another between $CaAl_2$ and Ca at 73% Ca and 545°. A peritectic reaction occurs at 700° in alloys containing 13.9 to 42.5% Ca, forming $CaAl_2$ on cooling, from $CaAl_2$ and the liquid. Al dissolves 0.6% Ca at 616°, and 0.3% at room temperature. (*C. A.*)

Rapid volumetric determination of calcium oxide and magnesium oxide in mixtures. N. M. MILOSLAVSKII AND E. A. BILENKO. *Ukrainskii Khem. Zhurnal*, **3** [1], tech. pt., 37–41 (1928).—The method of Willstätter and Waldschmidt-Leitz (published in *Berichte* **19**, 1223), with insignificant modifications, has been thoroughly tested by M. and B. and has been found by them applicable to factory laboratories. Not more than 1 to $1^1/_2$ hrs. is required for a determination of Ca and Mg by this method. (*C. A.*)

Contribution to the theory of the melting process and of the specific heat of liquid metals. A. MAGNUS. *Z. anorg. allgem. Chem.*, **171**, 73–81 (1928).—M. discusses several theories advanced to elucidate the melting of solids, such as the kinetic interpretation of Lindeman and the quantum expositions of the phenomenon. A question arises as to whether the lattice is completely disrupted at the melting point or whether "fragments of the lattice" remain, this débris disappearing upon further rise of temperature of the melt. M. applies quantum considerations to the change of internal energy with temperature by use of the formula for the energy of N atoms (or oscillators) with 3 degrees of freedom, $U = 3N[h\nu/(e^{(h\nu/kt)} - 1)] + U_o$. Tests of the theoretical material with the data for C_v for Hg (liquid) reveals a fair agreement. The discrepancies may be attributed to the incomplete destruction of the lattice at the melting point more than the theoretical amount of energy being required for C_v of the liquid since additional energy for the disruption of the lattice fragments must be supplied. Theoretical corrections, applied on the basis of this assumption, are in accord with experiment. (*C. A.*)

Adsorption phenomena with clays in nonaqueous media. B. NEUMANN AND S. KOBER. *Kolloidchem. Beih.*, **27**, 1–43 (1928).—Measurements of the adsorption of a silver xylosol have shown that the peculiar relations of heated clay toward the adsorption of nonaqueous dye solutions and vegetable oils are to be traced to the different degrees of dispersion. A differentiation is made between the adsorption of crystalloidal and colloidal matter by clays. Investigation of the adsorption of a large number of substances showed a continuous progression from crystalloidal to colloidal behavior. Silver xylosol and a gold-resin sol furnish examples of purely colloidal adsorption. Curves relating the adsorption of gold sol to the temperature of heating are given for some clays, and irregularities are traced to gas adsorption. It is concluded that the essential alteration taking place in clays on heating is a reversible change in capillary structure. (*B. C. A.*)

Firing of clays in the presence of water vapor and sulphur dioxide. J. KONARZEWSKI AND B. KRYNSKI. *Przemysl Chem.*, **12**, 176–84 (1928).—Below 550° the dehydration of china clay is retarded by the presence of water vapor; above this temperature the velocity of dehydration is unaffected by this factor. The presence of sulphur dioxide has no influence on the velocity of dehydration; the fired clay, however, contains in this case sulphates of calcium, magnesium, aluminium, and iron. The sulphur can be entirely eliminated by refiring in an oxidizing atmosphere. Alumina and ferric oxide can to a certain extent be extracted from fired clay by hydrochloric acid. (*B. C. A.*)

Internal friction in solids. A. L. KIMBALL AND D. E. LOVELL. *Metallurgist*, **3**, 140–41 (1927).—A summary of a paper by K. and L. (*Mech. Eng.*, **49**, 440–44 (1927)). (*J.I.M.*)

Internal friction in metals. R. H. CANFIELD. *Proc. Amer. Phys. Soc.*, Feb. 1928; *Phys. Rev.*, **31** [2], 713 (1928).—A tubular specimen of metal is used as the elastic control of a heavy metal pendulum which is set into forced vibrations by electro-magnetic forces. The mode of vibration is either torsional or transverse, so that the internal friction is determined for two types of stress; the principle being analogous to Searles' method of determining elastic constants. Observations are made on the maximum amplitude (peak of resonance curve) from which the friction constants are easily deduced. Logarithmic decrement observations can be made, and agree with the results of the other method. The phase of the vibration relative to the impressed forces can be determined,

and leads to Kimball's conclusion that the dissipative stresses are nonviscous. Preliminary results show two definite discontinuities in the relation between dissipated energy and stress amplitude, of which one depends on the mechanical history of the specimen, and the other is independent of it. (*J.I.M.*)

Determination of alkalis in ores, clays, and refractory materials. J. CIOCHINA. *Z. anal. Chem.*, **71**, 45 (1927).—The finely ground refractory is heated in a current of hydrogen sulphide in a steel, copper, or nickel boat in a silica tube for 2 hrs. at 500–600°C. The product is extracted with hot water and the insoluble matter retreated as above. Magnesium and calcium are removed from the combined solutions by means of a current of carbon dioxide, and the cooled filtrate is treated with an excess of standard iodine followed by 30 cc. of 1:3 hydrochloric acid. The excess of iodine is titrated with thiosulphate, and the iodine consumption is calculated to alkali which has been converted to sulphide by the heating operation. (*J.I.M.*)

Elasticity and plasticity. E. G. COKER. *Proc. Inst. Mech. Eng.*, **2**, 897–941 (1926).—The following subjects are considered: determinations of stress distribution in elastic bodies; comparison of stress distributions in different elastic materials; shear stress diagrams; theories of failure of elastic condition of materials; plasticity; and distribution of shear stress in twisted shafts. C. also considers some of the more recent developments in the science and technique of photo-elasticity. A bibliography of 41 references is included. (*J.I.S.I.*)

BOOKS

Introduction to Crystal Analysis. WILLIAM BRAGG. G. Bell & Sons, Ltd., London, 1928. Price 12*s*. H.H.S.

The Principles of Measurement. N. R. CAMPBELL. Longmans, Green & Co., London, 1928. Price 12*s*. 6*d*. H.H.S.

Introduction to Modern Physics. F. K. RICHTMYER. 596 pages, 169 illustrations. McGraw-Hill Book Co., Inc., New York, 1928. Price $5.00.—After an historical sketch to the year 1890, the chapters discuss the electromagnetic theory of light, moving charges, the photo-electric effect, the quantum theory, line spectra, the nuclear atom, electronic arrangement in atoms, X-rays, and the nucleus. H.H.S.

The Colloidal Salts. HARRY BOYER WEISER. McGraw-Hill Book Co., 1928. 404 pp. Price $5.00. Reviewed in *Min. and Met.*, **9** [262], 475 (1928).—This book is a critical summary of the colloidal behavior of the salts with particular reference to their rôle in the study of colloid chemistry phenomena and to the theory underlying their technical application. The first part of each section is devoted to a critical survey of the colloidal characteristics of the individual salts and the second part to the general theory of the applications which are concerned with their colloidal behavior. The volume is intended as an aid to students and research workers in both theoretical and applied science. F.P.H.

Keramische Materialkunde. GEZA JAKO. Published by Theodore Steinkopf, Dresden and Leipzig. 153 pages. A revision of an earlier publication with new chapters on calculations and fuels. This book is an elementary treatise on ceramic materials, designed for the untrained ceramic students.

The Microscope: A Practical Handbook. LEWIS WRIGHT. Enlarged and rewritten by A. H. Drew. London: R. T. S. 293 pp. 7*s*. 6*d*., net. (*C. A.*)

PATENTS

Production of commercial borax from rasorite by a wet method. THOMAS M. CRAMER. U. S. 1,685,214, Sept. 25, 1928. In the production of a commercial borax from a solution-resistant sodium borate mineral typically containing 4 molecular proportions of water to 2 molecular proportions of B_2O_3, a method which comprises sub-

jecting the mineral to the action of a form of water at a temperature substantially above 212°F.

Process of manufacturing complex hydrofluoric salt. MAX BUCHNER. U. S. 1,685,628, Sept. 25, 1928. Process of manufacturing complex hydrofluoric salts, which comprises reacting on an alkali earth metal fluoride with the fluoride of an element of the group consisting of silicon and boron in the presence of a salt of the alkali metal whose complex hydrofluoric salt shall be produced.

Boric acid. AMERICAN POTASH & CHEMICAL CORP. Brit. 294,236, Sept. 12, 1928. In a cyclic process for preparing boric acid, borax, which may be partly or wholly dehydrated, is treated with sulphuric acid, and boric acid separated by crystallization. Borax and water are added to the mother liquor which is cooled to separate sodium sulphate. The residual liquor is mixed with sulphuric acid and borax and again treated for the separation of boric acid.

Silica; titanium oxide. P. SPENCE & SONS, LTD., T. J. I. CRAIG, AND A. KIRKHAM. Brit. 294,681, Sept. 19, 1928. Siliceous residues obtained in the acid treatment of silicates decomposable by mineral acids with removal of alumina, iron oxide, alkalis and alkaline earths are dissolved in sodium or potassium carbonate solution, at about 160°C and under 80 lb. pressure if the carbonate and silica are about in molecular proportions and at lower temperatures and pressures if more carbonate is used. Titanium oxide if present in the original materials, *e.g.* clay or bauxite, remains in the residue. The solution of silicate is decomposed by passing carbon dioxide into it or by adding bicarbonate solution, to precipitate silica in a flocculent form. The precipitate is washed with water and acid, to remove alkali, and finally with water and may be dried and sieved.

Silicates. FERDINAND RICARD. Fr. 632,509, April 9, 1927. Na_2SiO_3 is formed by adding a powdered SiO_2 mineral to NaOH, which is treated with CO_2 to saturation, giving a precipitate of SiO_2, or the solution of Na_2SiO_3 is treated with slaked lime to give $CaSiO_3$, the solution in each step being used again in the process. (*C. A.*)

General

Annual meetings. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [10], 301–302 (1928).—The annual meetings of the AMERICAN CERAMIC SOCIETY are for personal inspiration, for broadening and strengthening acquaintances, and for collectively planning the most effective means of promoting ceramics, and are not planned for the purpose of acquiring "copy" for the *Journal*. They afford an opportunity for the men from the clay, glass, and vitreous enamel industries to exchange experiences, theories, and ambitions, which if denied them, would result in narrowing of concepts and limitations in vision. E.J.V.

Exposition of ceramic products. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [10], 302 (1928).—Expositions of products for the education of ultimate purchasers are a means of telling the service value of ceramic products and do not duplicate other means, such as national and direct mail advertising, of making known the service advantages of the products. They serve the same ultimate purpose of increasing sales but their appeal is differently directed. E.J.V.

Technical classes for pottery and glass. ANON. *Pottery Gaz.*, **53** [616], 1626–28 (1928).—Additional information regarding technical pottery and glass classes in Stoke-on-Trent, Burslem, London, Leicester, and Salford. See also *Ceram. Abs.*, **7** [11], 772 (1928). E.J.V.

The glass convention. ANON. *Pottery Gaz.*, **53** [616], 1629–33 (1928).—A report of the first Glass Convention held in England, in September. The members were officially welcomed by the mayor of Bournemouth, and Walter Butterworth, president of the convention, addressed them on the subject of "The British Glass Industry." E.J.V.

Improve products through research. ANON. *Abrasive Ind.*, 9 [9], 239 (1928).—"Use of Research in Developing Old Products and Introducing New Ones," is the title of a booklet published by the Metropolitan Life Insurance Co. It contains numerous specific examples of how this is being done. E.P.R.

Precision value for the inch is advocated. LUTHER BURLINGAME. *Abrasive Ind.*, 9 [10], 267–69 (1928).—The advisability of adopting the metric system of weights and measures is discussed. E.P.R.

Pioneer optical glass manufacturers celebrate 75th anniversary. ANON. *Amer. Glass Rev.*, **47** [51], 15–16 (1928); *Instruments*, 1 [9], 389–92 (1928).—The Bausch & Lomb Optical Co., Rochester, N. Y., which made the first optical glass in America, is celebrating its 75th anniversary this year. Appropriate observation of this event is being made in the Bausch & Lomb Magazine. The story of the Bausch & Lomb Optical Co., is one of early struggle, obstacles overcome, and finally success. E.P.R.

Vitrification of clay products. A. T. GREEN. *Refract. Jour.*, **3** [33], 846 (1928).—The article is a commentary on a series of lantern slides exhibiting the numerical values resulting from tests for porosity, sealed-pore volume, etc., of certain fireclay products fired to the vitrifying range. The main outstanding indication was that, although total porosity generally decreased steadily before incipient vitrification, this was followed by a decided increase, though the apparent porosity continued to decrease. It was found that the sealed-pore volume increased considerably during vitrification. Such increase in sealed-pore volume does not appreciably reduce mechanical strength of the vitrified material. E.P.R.

National Association of Clayworks Managers. ANON. *Refract. Jour.*, **3** [33], 852 (1928).—A meeting of the Sheffield Branch of the National Association of Clayworks Managers was held at the Royal Victoria Hotel, May 2, 1928. A lecture was heard on the "Ball and Roller Bearings (heavy) with Particular Attention to Brick-making Machines." E.P.R.

Institute of British Foundrymen convention. ANON. *Refract. Jour.*, **3** [34], 876 (1928).—The twenty-fifth annual meeting and conference of the Institute of British Foundrymen was held in Leicester, June 12 to 15. E.P.R.

Sand problems. ANON. *Foundry Trade Jour.*; *Refract. Jour.*, **3** [34], 923–27 (1928).—The article is a discussion of a paper on the "Cohesibility of Rammed Sand," by IVAN LAMOUREUX (President of the Liege-Limbourg-Luxemburg Section of the Association Technique de Fonderie of Belgium) for the Leicester Conference of the Institute of British Foundrymen. E.P.R.

Furnace volume and combustion. HARRY JACOBS. *Blast Fur. Steel Plant*, **16** [9], 1216–17 (1928).—The basis of steam generation can be divided into three main factors: (1) crude or original source of heat, *e.g.*, oil, coal, etc., (2) the conversion into heat or B.t.u.; and (3) the transposing of the B.t.u. into a medium that can be controlled, such as steam. The first or crude form of the B.t.u. may be considered as coal, which may be divided into two clearly defined types, (*a*) pure carbon (commonly known as anthracite) the chief characteristic of which is a very short flame, and the greater portion of the heat of which is radiant heat; (*b*) great variation of qualities, all of which are embraced under the one heading "bituminous." It is this large range and the inability to produce exactly the same type of coal that make the consideration of combustion a very difficult problem; in fact, combustion with all its various phases bears a greater responsibility for poor boiler efficiency than all the rest of the equipment employed in the generation of steam. It is therefore this factor which should receive greater attention and study. The third factor referred to is the conversion of the B.t.u. into a controllable form such as steam. This conversion or transposition is taken care of in the boiler. The type of this equipment does not seem so important as the final harnessing of the B.t.u., although it receives a great deal of the attention as to the merits of one type or another of boiler.

One thing that is fairly well established is the actual transmission of heat from the furnace to the boilers, *i.e.*, just how many heat units can be crowded through a given area of boiler surface in a given time. F.P.H.

Crushing and grinding. II. The relation of measured surface of crushed quartz to sieve sizes. JOHN BROSS AND S. R. ZIMMERLEY. *Min. and Met.*, **9** [262], 465 (1928).—The calculation of surface for quartz based on average size as obtained by sieve sizing is subject to serious error. Surface measurements of sieve sizes of crushed quartz show that the ratio of measured to theoretical surface is large for coarser particles and gradually diminishes as the particles become finer. This difference is due almost entirely to fractures, the surfaces of which are measured in part, and probably to a large extent, by the dissolution method. The surface measurements of sieve sizes of Ottawa sand show a fairly constant ratio of measured to theoretical surface, because this sand is practically free from fractures. The outer surface of sieve sizes of crushed quartz also shows a fairly constant ratio of measured to theoretical surface. The graph showing the logarithmic relation between surface per unit weight and size of particle may be extended to the unit crystal of quartz as a slight curve for crushed quartz and as a straight line for Ottawa sand. From this graph the average size of particles may be obtained from any sample of quartz after the surface has been determined. The constant relation of the measured to theoretical surface for Ottawa sand and for the outer surface of crushed quartz, and the extension to unit crystals of the logarithmic relation of surface to size of particles, are considered as further evidence of the accuracy of the dissolution method for surface determinations. The −200-mesh material is of greater importance than the coarser sizes in the study of crushing and grinding operations. The average size of particles in a −200-mesh crushed product is usually much smaller than 37 microns. Much of the work in crushing and grinding is expended in producing finer material than is required. By the measurement of surface of crushed material, an index of the useful work may be ascertained. **III. Relation of work input to surface produced in crushing quartz.** A crushing device has been developed whereby the net work input to a crushing operation can be accurately determined. Surface determinations may be made on a crushed quartz sample, as such a measurement has been shown to be equal to the sum of the measured surfaces of the component sizes. The data show that when crushing quartz the new surface produced is in direct proportion to the work input in accordance with the Rittinger law of crushing. Surface measurements show that the major portion of the work expended, even in comparatively coarse crushing, is represented in the −200-mesh material. F.P.H.

Commercial treaties with Greece: tariffs on ceramic ware. ANON. *Keram. Rund.*, **36**, 374–76 (1928). H.I.

Modern power drive increases dividends. W. STANIAR. *Chem. Met. Eng.*, **35**, 533–35 (1928). M.E.M.

Well designed buildings pay their way. H. K. FERGUSON. *Chem. Met. Eng.*, **35**, 536–37 (1928). M.E.M.

Production control: an essential tool of modern business. G. A. PROCHAZKA, JR. *Chem. Met. Eng.*, **35**, 538–39 (1928).—Illustrates a graphic form for control of production, sales, and inventories. M.E.M.

Aluminum in Norway and Spain. ANON. *Chem. and Ind.*, **47**, 934–35 (1928).—The Pedersen process for the manufacture of Al from French bauxite is being worked by the Norsk Aluminium Co. A half interest in this company is held by the American Aluminum Co. Iron is a by-product of the process. Aluminum has not yet been made in Spain, but a factory at Sabiñanigo in the province of Huesca has been established by the Soc. Aluminio Español with an installation of 60 Söderberg furnaces. H.H.S.

Basalt as insulating material. ANON. *Chem. and Ind.*, **47**, 935 (1928).—Basalt, which has been melted at 1300°C and cast, was produced some years ago in France by

the Ribes process. A factory recently established near Verona, Italy, grinds the basalt and fuses it at 1400 to 1500°C, after which it is forced into molds and subjected to a heat treatment. High tension insulators have been made which are highly efficient and are sold very cheaply. H.H.S.

Metric system in Mexico. ANON. *Science*, **68**, 181 (1928).—The use of weights and measures other than metric is prohibited by law. All articles must be sold by weight, measure or volume expressed in metric units. This prohibits the sale of "package" goods as such. H.H.S.

Calculations derived from industrial practice. PAUL POTTIG. *Sprechsaal*, **61** [12], 215–19 (1928).—Due to present high cost of manufacture and close competition the author claims exact knowledge of costs in ceramic manufacture are essential. Drawings are given to show how the raw materials entering into ceramic manufacture as well as the finished product may be diagrammatically kept both by weight and percentage. Exact knowledge of costs of all raw materials, finished products, overhead, defective and broken ware can be kept by such records. R.A.H.

BOOKS

Niagara Power: Vol. I. History and Power Projects. Vol. II. Construction and Operation. E. D. ADAM. Niagara: The Niagara Falls Power Co., 1928. H.H.S.

The Recovery and Use of Industrial Wastes. J. B. C. KERSHAW. With foreword by Max Muspratt. E. Benn, Ltd., London, 1928. Price 25*s*. H.H.S.

Catalogue of the Home Office Industrial Museum and Exhibits. Pages 178. H. M. Stationery Office, London, 1928. Price 3*s*. 6*d*.—The permanent exhibition of methods and appliances for promoting the welfare of industrial workers opened in London last December. The present volume, which is the official catalog of the Museum, contains a large number of full-page plates and information on the experience gained by the Home Office on questions of safety and welfare in industry. Reviewed in *Engineering*, **126**, 81 (1928). H.H.S.

Business Cycles, the Problem and Its Setting. WESLEY C. MITCHELL. National Bureau of Economic Research, 1928. 469 pp. Price $6.50. Reviewed in *Min. and Met.*, **9** [262], 475 (1928).—This book takes up current theories of business cycles, present day economic organizations, the analysis of modern statistical methods and business indexes, gives a summary of world-wide historical records and a working concept of business cycles. The general plan of this work is similar to an earlier book on the subject by the same author, but the statistical data have proved so extensive that they will be published separately in a series of volumes instead of being included with the theoretical discussions. F.P.H.

Blasters' Handbook. LAMOTTE AND STAFF. E. I. Dupont de Nemours Co., Wilmington, 1928. 215 pp. Reviewed in *Min. and Met.*, **9** [262], 474 (1928).—This convenient handbook, of pocket size, covers broadly the whole field of use of explosives. The various kinds are concisely described and their transportation, handling and storage discussed. Blasting accessories are described in more detail and the operations of blasting are especially well treated. Such special applications as setting telephone poles, planting trees, breaking up frozen material in railroad cars, etc., are adequately treated, but most of the space is appropriately devoted to ore mining and tunnel drilling. Tables and a bibliography are included. F.P.H.

The New Human Interest Library. Vol. 3. Midland Press, Chicago.—This book was prepared for school children. The chapters dealing with glass, brick, enamelware, and china would be interesting and informing to the best informed in these respective industries. It is well illustrated.

Book Reviews

1928 Chemical Engineering Catalog. Published by the Chemical Catalog Co., Inc., New York City.—A condensed and standardized catalog data of equipment, machinery, laboratory supplies, heavy and fine chemicals, and raw material used in the industries employing chemical processes. It has extensive cross references, classified indexes, and a list of technical and scientific books. Price $3.00. The volume is published annually under the supervision of an official committee appointed by the American Institute of Chemical Engineers, the American Chemical Society, and the Society of Chemical Industry. The most notable change from previous editions is the separation of the index into two parts, (1) equipment and supplies and (2) chemicals and raw materials. A special index of trade names is given. There are 2400 books described and listed by author and subject. It is a book full of equipment and method suggestions and as such worth many times the price.

Bituminous Coal Fields of Pennsylvania. General Information about Coal. GEORGE H. ASHLEY. U. S. Geol. Surv., *Bull*, M6, Part I. 241 pages, 17 plates, 32 figures, price 50 cents.—A general discussion of coal and of Pennsylvania bituminous coal in particular. It discusses at some length the physical and chemical character of coal, its origin and classification, the coal bed and what may happen to it, and the age of coal. About 100 pages are devoted to a description of the bituminous coal of Pennsylvania and its distribution by countries. Space is also given to a brief description of the mining methods in use in the bituminous fields of Pennsylvania, and to the uses of Pennsylvania bituminous coal, including some future uses toward which there is a present trend.

Anthracite Culm and Silt. JAMES D. SISLER, THOMAS FRASER, AND DEVER C. ASHMEAD. U.S. Geol. Surv., *Bull.*, M12, 259 pages, 34 plates, 21 figures, price 50 cents. —Results are given of a detailed study of the problems of culm and silt as they affect the anthracite fields of Pennsylvania. The production and uses of anthracite culm and silt are described, the results of detailed studies in silt and culm discharge at the breakers are cited, as well as of the recovery of this coal in the rivers and creeks flowing from the anthracite region. These are followed by the methods and results of sampling culm and silt accumulations in the field. This report is the result of a study made by the Topographic and Geologic Survey in coöperation with the Pennsylvania Water and Power Resources Board and the U. S. Bureau of Mines.

For the above bulletins address Bur. of Publications, Dept. of Property and Supplies, Harrisburg, Pa.

LIST OF PUBLICATIONS*

The following list of publications represents those from which abstracts have been published in *Ceramic Abstracts* for 1928. A few journals, chiefly foreign publications are omitted because of lack of definite information concerning them. The editor will be glad to receive corrections or additions to this list. Grateful acknowledgment is made for assistance in compiling this list to Miss Kellicott, Ohio State University Library, E. H. McCelland, Technology Librarian, Carnegie Library of Pittsburgh, and to Chemical Abstracts, "List of Publications."

Abrasive Industry,
Penton Publishing Co., Cleveland, Ohio.
Academiae scientiarum Fennicae, Anneles,
Suomalaisen Tiedeakatemian Kustantama, Helsingfors, Finland.
Allgemeine Glas- und Keram-Industrie,
T. F. Rimpler, Haida, Germany.
American Architect and Architectural Review,
239 W. 39th St., New York City.
American Association of Textile Chemists and Colorists,
Howes Publishing Co., 90 William St., New York City.
American Astronomical Society, Journal,
Ann Arbor, Mich.
American Ceramic Society, Bulletin, Abstracts, Journal.
2525 N. High St., Columbus, Ohio.
American Chemical Society, Journal,
Charles L. Parsons, Mills Bldg., Washington, D. C.
American Concrete Institute, Proceedings,
2970 W. Grand Blvd., Detroit, Mich.
American Dyestuff Reporter,
Howes Publishing Co., 90 William St., New York City.
American Electrochemical Society, Transactions,
Columbia University, New York City.
American Enameler,
Porcelain Enamel & Mfg. Co., Baltimore, Md.
American Foundrymen's Association, Transactions,
C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.
American Glass Review,
Commoner Publishing Co., Box 555, Pittsburgh, Pa.
American Illuminating Engineering Society, Transactions,
29 W. 39th St., New York City.
American Institute of Chemical Engineering, Transactions,
Polytechnic Institute, Brooklyn, N. Y.
American Iron and Steel Institute, Year Book,
40 Rector St., New York City.
American Journal of Science,
New Haven, Conn.
American Machinist,
McGraw-Hill Book Co., 10th Ave. at 36th St., New York City.
American Magazine of Art,
American Federation of Arts, 1741 New York Ave., New York City.
American Mineralogist,
Alexander H. Phillips, Princeton University, Princeton, N. J.
American Physical Society, Bulletins, Reports of Education Committee,
Ithaca, N. Y.
American Refractories Institute, Bulletin,
2202 Oliver Bldg., Pittsburgh, Pa.
American Society for Steel Treating, Transactions,
4600 Prospect Ave., Cleveland, Ohio.
American Society for Testing Materials, Proceedings,
1315 Spruce St., Philadelphia, Pa.
American Zinc Institute, Bulletin,
27 Cedar St., New York City.

*All publications of societies are listed under the names of the societies.

Analele minelor din Romania,
Str. Lascar Calargiu 17, Bucharest, Roumania.
Annalen der Physik,
Johann Ambrosius Barth, Dorrienstr. 16, Leipzig, Germany.
Apotheker Zeitung,
Deutsche Apotheker Verein, Levetzowstr. 16B, Berlin, N. W., Germany.
Architecture,
Charles Scribner's Sons, 5th Ave. at 48th St., New York City.
Architectural Forum.
Rogers & Manson, 383 Madison Ave., New York City.
Architectural Record,
115 West 40th St., New York City.
Archiv für das Eisenhüttenwesen, Verlag Stahleisen,
Breite, Str. 27, Düsseldorf, Germany.
Archiv für elektrotechnik,
Julius Springer, Linkstr. 23/24, Berlin, W. 9, Germany.
Archiv für Warmewirtschaft und Dampfkesselwesen,
Dorotheenstr. 40, Berlin, N.W. 7, Germany.
Art and Archaeology,
The Octagon Annex, Washington, D. C.
Art et decoration,
Rue de l'Echelle 2, Paris, France.
Arts and Decoration,
45 West 45th St., New York City.
Arts et Métiers,
15 Blvd. St. Martin, Paris, France.
Association of Official Agricultural Chemists, Journal,
Box 290, Pennsylvania Ave. Sta., Washington, D. C.
Astrophysical Journal,
Univ. of Chicago Press, 5750 Ellis Ave., Chicago, Ill.
Atti della reale accademia nazionale dei Lincei,
Dott. Giovanni Bardi, Tipografia della r. accademia nazionale dei Lincei, Rome, Italy.
Atti del congresso nazionale di chimica pura ed applicata,
Associazione italiana di chimica generale ed applicata, Via 4 Novembre 154, Rome, Italy.
Australia Advisory Council of Science & Industry, Bulletins,
Inst. of Science and Industry, 314 Albert St., East Melbourne, Australia.
Australian Institute of Mining and Metallurgy, Proceedings,
Collins Court, 374 Little Collins St., Melbourne, Australia.
Baumarkt,
Uferstr. 21, Leipzig, C. 1, Germany.
Berichte der deutschen chemischen Gesellschaft,
Sigismundstr. 4, Berlin, W. 10, Germany.
Berichte der deutschen keramischen Gesellschaft,
Ringbahnstr. 10, Berlin-Halensee, Germany.
Berichte der Fachausschüsse des Vereins deutschen Eisenhüttenleute,
Breite Str. 27, Düsseldorf, Germany.
Berichte der Werkstoffauschuss des Vereins deutschen Eisenhüttenleute,
Breite Str. 27, Düsseldorf, Germany.
Beton und Eisen,
Wilhelm Ernst & Sohn, Wilhelmstr. 90, Berlin, W. 66, Germany.
Blast Furnace and Steel Plant,
The Andresen Co., Inc., 108 Smithfield St., Pittsburgh, Pa.
Brass World and Platers' Guide,
Brass World Publishing Co., 153 Waverly Place, New York City.
Braunkohle,
Wilhelm Knapp, Mühlweg 19, Halle, (Saale), Germany.
Brennstoff-chemie,
Verlag von W. Girardet, Essen, Germany.
Brennstoff- und Warmewirtschaft,
Wilhelm Knapp, Mühlweg 19, Halle (Saale), Germany.
Brick and Clay Record,
407 S. Dearborn St., Chicago, Ill.

British Association of Chemists,
Empire House, 175 Piccadilly, London, W. 1, England.
British Cast Iron Research Association, Bulletin,
Central House, 75 New St., Birmingham, England.
British Clayworker,
43 Essex St., Strand, London, England.
British Dental Journal,
23 Russell Sq., London, W.C. 1, England.
British Engineering Standards Assn.,
28 Victoria St., London, S.W. 1.
British Geological Survey, Memoirs,
H. M. Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.
British Industries,
39 James St., London, S.W. 1, England.
British Scientific Instruments Research Association,
22 Russell Sq., London, W.C. 1, England.
British Society of Master Glass Painters,
6 Queen Sq., London, W.C. 1, England.
Building Research, Technical Papers,
Dept. of Scientific and Industrial Research, 16 Old Queen St., Westminster, S.W. 1., London, England.
Bulletin technique de la suisse romande,
Lausanne, Switzerland.
Cambridge Philosophical Society, Proceedings,
Cambridge University Press, Fetter Lane, London, E.C. 4, England.
Canada, The Honorary Advisory Council for Scientific and Industrial Research, Ottawa, Canada.
Canadian Bureau of Mines Publications,
Canadian Dept. of Mines, Ottawa, Canada.
Canadian Chemistry and Metallurgy,
Westman Press, Ltd., 57 Queen St., West., Toronto, 2, Canada.
Canadian Engineer,
Monetary Times Printing Co. of Canada, 62 Church St., Toronto, Canada.
Canadian Foundryman and Electroplater,
MacLean Publishing Co., 153 University Ave., Toronto, Canada.
Canadian Institute of Mining and Metallurgy, Bulletins,
603–604 Drummond Bldg., Montreal, Quebec, Canada.
Canadian Machinery and Manufacturing News,
MacLean Publishing Co., 153 University Ave., Toronto, Canada.
Cement and Engineering News,
Tradepress Publishing Corp., 542 S. Dearborn St., Chicago, Ill.
Cement, Mill, and Quarry,
515–22 Monadnock Bldg., 53 W. Jackson Blvd., Chicago, Ill.
Centralblatt der Hütten und Walzwerke,
Dr. Ing. G. Stauber, Berlin S.W. 48, Wilhelmstrasse 8, Germany.
Centralblatt für Mineralogie, Geologie und Paläontologie,
E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nagele) G.m.b.H., Johannestr. 3a, Stuttgart, Germany.
Ceramic Age,
The Ceramic Publishing Co., 189 S. Broad St., Trenton, N. J.
Ceramic Industry,
407 S. Dearborn St., Chicago, Ill.
The Ceramic Society (England) Transactions,
Stoke-on-Trent, England.
Ceramics and Glass,
Scientific-Technical Council of Glass and Porcelain Industry, 8/2 Miasnitskaia, Moscow, U.S.S.R.
La Ceramique,
84 rue d'Hauteville, Paris (Xe), France.
Ceramique et Verrerie,
13 rue de Petites-Ecuries, Paris, France.
Chaleur et industrie,
5 rue Michel-Ange, Paris, France.
Chemical Age,
Benn Brothers, Ltd., Bouverie House, 154 Fleet St., London, E.C. 4, England.

Chemical Engineering and Mining Review,
Tait Publishing Co., 39 Queen St., Melbourne, Australia.
Chemical Markets,
Drug and Chemical Markets, Inc., 25 Spruce St., New York City.
Chemical and Metallurgical Engineering,
McGraw-Hill Book Co., Inc., 10th Ave. at 36th St., New York City.
Chemical, Metallurgical, and Mining Society of S. Africa, Journal,
H. A. G. Jeffreys, P. O. Box 1183, Scientific and Technical Club, 100 Fox St., Johannesburg, S. Africa.
Chemical Society (London), Journal,
Burlington House, London, W. 1, England.
Chemical Technology (Japan),
Kagaku-Kogei-Sha, Kiriu, Japan.
Chemical Trade Journal and Chemical Engineering,
Davis Bros., 265 Strand, London, W.C. 2, England.
Chemie der Erde,
Gustav Fischer, Jena, Germany.
Chemiker-Zeitung,
Walter Roth, Cothen, Germany.
Chemische Fabrik,
Verlag Chemie, G.m.b.H., Berlin, W. 10, Germany.
Chemische Rundschau für Mitteleuropa und den Balkan,
Eskü-ter 5, Budapest IV, Hungary.
Chemisch Weekblad,
D. B. Centen, O. Z. Voorburgwal 115, Amsterdam, Holland.
Chemisches Zentralblatt,
Deutschen Chemischen Gesellschaft, Sigismundstr. 4, Berlin, W. 10, Germany.
Chemist-Analyst,
J. T. Baker Chemical Co., Phillipsburg, N. Y.
Chemistry and Industry,
Central House, 46–47 Finsbury Sq., London, E.C. 2, England.
Chimie et industrie,
Société de chimie industrielle, 49 rue de Mathurins, Paris, France.
Le Ciment,
Société anonyme de publications industrielles, 20 rue Turgot, Paris (IXe), France.
Classe des sciences academie royale de Belgique, Bulletin,
Maurice Lamertin, 58–62 rue Condenberg, Brussels, Belgium.
Clay Products News and Ceramic Record,
Keith-Wilkes, 79 Adelaide St., East, Toronto 2, Canada.
The Clay-Worker,
T. A. Randall & Co., Inc., 211 Hudson St., Indianapolis, Ind.
Colliery Engineering,
33 Tothill St., Westminster, London, S.W. 1, England.
Colliery Guardian,
30–31 Furnival St., Holborn, London, E.C. 4, England.
Color Trade Journal and Textile Chemist,
51 Vesey St., New York City.
Combustion,
Combustion Publishing Co., 11 Broadway, New York City.
Commercial and Industrial Gazette,
Pretoria, S. Africa.
Comptes rendus hebdomadaires des séances de l'académie des sciences,
Gauthier-Villars et Cie, 55 Quai des Grands-Augustins, Paris (6 e), France.
Concrete,
Concrete Publishing Co., 139 N. Clark St., Chicago, Ill.
The Connoisseur,
1 Duke Street, St. James, S.W. 1, London, England.
Continental Metallurgical & Chemical Engineering,
20 Dartmouth St., Westminster, London, S.W. 1, England.
Contract Record and Engineering Review,
H. C. MacLean Publications, Ltd., 347 Adelaide St., West, Toronto 2, Ontario, Canada.
Contributions to the Study of the Natural Resources of the U. S. S. R.,
Myasnitzkaya 1, Moscow, U. S. S. R.

Corriere dei Ceramisti,
Via Mazzini 6, Perugia, Italy.
Crockery and Glass Journal,
Demarest Publications, Ltd., 45 East 17th St., New York City.
Department of Scientific and Industrial Research Publications,
H. M. Stationary Office, Adastral House, Kingsway, London, W.C. 2, England.
Design and Keramik Studio,
Keramic Studio Publishing Co., 307 S. Franklin St., Syracuse, N. Y.
Deutsche Essigindustrie,
Paul Parey, Hedemannstr. 10–11, Berlin, S.W. 11, Germany.
Deutsche Zeitschrift für die gesamte gerichtliche Medizin,
Julius Springer, Linkstr. 23–24, Berlin, W. 9, Germany.
Diamant,
Keilstr. 1, Leipzig, Germany.
Economic Geology,
Prince and Lemon Sts., Lancaster, Pa.
Electrical Review,
Electrical Review Ltd., 4 Ludgate Hill, London, E.C. 4, England.
Electrical World,
McGrav-Hill Book Co., 10th Ave. at 36th St., New York City.
Electroplaters' and Depositors' Technical Society, Journal,
Northampton Polytechnic Institute, St. John St., Clerkenwell, London, E.C. 1, England.
Electro-Technical Laboratory, (Tokyo, Japan), Researches,
Publishing Dept. of Kosei-kwai, 1 Otemachi, Kojimachi-ku, Tokyo, Japan.
Elektrotechnische Zeitschrift,
Linkstr. 23/24, Berlin W. 9, Germany.
Elisha Mitchell Scientific Society, Journal,
University of North Carolina, Chapel Hill, N. C.
Emailleindustrie,
Verlag "Die Glashütte," Strehlener Str. 20, Dresden—A 24, Germany.
The Enamelist,
The Enamelist Publishing Co., 2100 Keith Building, Cleveland, Ohio.
Engineer,
33 Norfolk St., Strand, London, W.C. 2, England.
Engineering,
35–36 Bedford St., Strand, London, W.C. 2, England.
Engineering and Boiler House Review,
Engineering Review Co., 13–16 Fisher St., Southampton Row, London, W.C. 1, England.
Engineering and Mining Journal,
McGraw-Hill Book Co., Inc., 10th Ave. at 36th St., New York City.
Engineering News-Record,
McGraw-Hill Book Co., Inc., 10th Ave. at 36th St., New York City.
Faraday Society, Transactions,
Gurney and Jackson, 33 Paternoster Row, London, England.
Farbe und Lack,
Baringstr. 4, Hanover, Germany.
Farben-Zeitung,
Union Deutsche Verlagsgesellschaft, Krausenstr. 35/36, Berlin, S.W. 19, Germany.
Feuerfest,
Heinrichstr. 9, Leipzig–R, Germany.
Feuerungstechnik,
Heinrichstr. 9, Leipzig–Cl, Germany.
Forging, Stamping, and Heat Treating,
The Andresen Co., Inc., 108 Smithfield St., Pittsburgh, Pa.
Fortschritte der Mineralogie, Krystallographie und Petrographie,
Deutsche mineralogische Gesellschaft, Berlin, W. 35, Germany.
The Foundry,
The Penton Publishing Co., Cleveland, Ohio.
Foundry Trade Journal,
Industrial Newspapers, Ltd., 49 Wellington St., W.C. 2, London, England.
Franklin Institute, Journal,
Philadelphia, Pa.

Fuel Economist,
530 Abbey House, Victoria Street, S.W. 1, London, England.
Fuel Economy Review,
Fuel Economy Dept., Federation of British Industries, 39 St. James St., London, S.W. 1, England.
Fuel in Science and Practice,
Colliery Guardian Co., Ltd., 30–31 Furnival St., Holborn, London, E.C. 4, England.
Fuels and Furnaces,
F. C. Andresen and Associates, Inc., House Bldg., Pittsburgh, Pa.
Gas-Age Record,
Robbins Publishing Co., Inc., 9 E. 38th St., New York City.
Gas Journal,
Walter King, Ltd., 11 Bolt Court, Fleet St., London, E.C. 4, England.
Gas und Wasserfach,
R. Oldenbourg, Gluckstr. 8, Munich, Germany.
Gas World,
Bouverie House, 154 Fleet St., London, E.C. 4, England.
Gazzata Chimica Italiana,
Via Quattro Novembre 154, Rome (1), Italy.
General Electric Review,
General Electric Co., Schenectady, N. Y.
Genie civil,
6 rue de la Chaussee d'Antin, Paris (9e), France.
Geological Survey of Great Britain,
H. M. Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.
Geological Survey of New South Wales, Reports,
John Spence, Acting Government Printer, Sydney, Australia.
Giornale di bibliografia tecnica internazionale,
Societa generale delle messaggerie italiene, Via Milazzo N16, Bologna, Italy.
Giornale di Chemica Industriale ed Applicata,
Via S. Paolo 10, Milan (3), Italy.
Glas und Apparat,
Verlag R. Wagner Sohn, Weimar, Germany.
Glasindustrie,
Verlag "Die Glashütte," Strehlener Str. 20, Dresden–A 24, Germany.
Glas-industrie,
Mockernstr. 144, Berlin, S.W. 11, Germany.
Glass,
Glass Publications, Ltd., Talbot House, Arundel St., Strand, London, W.C. 2, England.
Glass Container,
O'Gorman Publishing Co., 22 E. 75th St., New York City.
Glass Industry,
Glass Industry Publishing Co., Inc., 50 Church St., New York City.
Glastechnische Berichte,
Deutschen glastechnischen Gesellschaft Frankfurt-am-Main, Germany.
Glasshütte,
Strehlener Str. 20, Dresden–A, 24, Germany.
Gluckauf, Berg- und Hüttenmännische Zeitschrift,
W. Beechmann, Verlag Gluckauf m.b.H., Essen, Germany.
Great Britain Government Reports, India, Government Publications, Technical Papers,
Calcutta, India.
Helvetica Chimica Acta,
Georg and Co., Basel, Switzerland.
Illinois State Geological Survey,
University of Illinois, Urbana, Ill.
Imperial Industrial Research Institute, Reports,
Dept. of Commerce and Industry, Osaka, Japan.
Indian Institute of Science, Journal,
Bangalore, India.
L'Industria,
Società editrice unitas, Viale Piave 12, Milan, Italy.
Industria del gas degli acquedotti,
Alberto Pacchioni, Ostiense 72, Rome, Italy.

Industrial Australian and Mining Standard,
Melbourne, Sydney, Australia.
Industrial Canada,
Canadian Manufacturers Assn., Toronto, Canada.
Industrial Chemist,
33 Tothill St., Westminster, London, S.W. 1, England.
Industrial and Engineering Chemistry,
Charles L. Parsons, Mills Bldg., Washington, D. C.
Industrie chimique,
H. Mounier, 8 rue de Miromesnil, Paris (8e), France.
De Ingenieur,
Paviljoensgracht 19, The Hague, Holland.
Institut d'analyse physico-chimique (Leningrad), Annales,
Leningrad, U. S. S. R.
Institution of Civil Engineers (London), Proceedings,
Great George St., London, S.W. 1, England.
Institute of Fuel Technology, Proceedings,
London, England.
Institute of Economic Mineralogy and Metallurgy (Moscow), Transactions,
Scientific-Technical Dept., of Supreme Council of National Economy, Myasnitzkaya 1, Moscow, U. S. S. R.
Institute of Mechanical Engineers (London), Proceedings,
Storey's Gate, St. James Park, London, S.W. 1, England.
Institute of Metals, Journal,
36 Victoria St., London, S.W. 1, England.
Institute of Physical and Chemical Research, Bulletin, Scientific Papers,
Iwanami Shoten, 16 Minami-Jimbocho, Kanda-Ku, Tokyo, Japan.
Instruments,
Instruments Publishing Co., Pittsburgh, Pa.
International Society of Soil Science, Proceedings,
International Institute of Agricultur, Villa Umberto 1, Rome (10), Italy.
International Studio,
49 West 45th St., New York City.
Iowa Academy of Science, Proceedings,
Old Science Hall, Iowa City, Iowa.
Iron Age,
239 W. 39th St., New York City.
Iron and Coal Trades Review,
49 Wellington St., Strand, London, W.C. 2, England.
Iron and Steel of Canada,
Industrial and Educational Publishing Co., Ltd., Garden City Press, Gardenvale, P. Q. Canada.
Iron and Steel Engineer,
Assn. of Iron and Steel Electrical Engineers, 706 Empire Bldg., Pittsburgh, Pa.
Iron and Steel Industry,
L. Cassier Co., Ltd., 22 Henrietta St., London, W.C. 2, England.
Iron and Steel Institute (London), Publications,
28 Victoria St., London, S.W. 1, England.
Iron Trade Review,
Penton Publishing Co., Cleveland, Ohio.
Japanese Ceramic Association, Journal,
Tajiro Kurahashi, 20 Omotecho, 2 Chome, Akasakaku, Tokyo, Japan.
Journal of Chemical Education,
Erle M. Billings, Kodak Park, Rochester, N. Y.
Journal of the College of Engineering, (Name changed to *Journal of the Faculty of Engineering.*)
Tokyo Imperial University, Tokyo, Japan.
Journal of Engineering Education,
Prince and Lemon Sts., Lancaster, Pa.
Journal du four electrique et des industries electrochimiques,
7 rue d'Offemont, Paris (17e), France.
Journal of Geology,
Univ. of Chicago Press, 5750 Ellis Ave., Chicago, Ill.
Journal of Physical Chemistry,
Baker Laboratory, Ithaca, N. Y.

Journal de physique et la radium,
L'administrateur, 12 place de Laborde, Paris (VIIIe), France.
Journal für praktische Chemie,
J. A. Barth, Salomonstr. 18b, Leipzig, Germany.
Journal of Scientific Instruments,
Cambridge University Press, Fetter Lane, London, E.C. 4, England.
Kentucky Academy of Science, Transactions,
Lexington, Ky.
Kentucky Geological Survey, Publications,
Frankfort, Ky.
Keramic Studio,
Keramic Studio Publishing Co., Syracuse, N. Y.
Keramische Rundschau,
Dreysestr. 4, Berlin, N.W. 21, Germany.
Keramos,
Verlag Aktiengesellschaft, Bamberg, 3, Germany.
Kodak Research Laboratory, Communications,
Eastman Kodak Co., Rochester, N. Y.
Kolloid-Zeitschrift,
Theodor Steinkopf, Residenzstr. 12b, Dresden-Blasewitz, Germany.
Kolloidchemische Beihefte,
Theodor Steinkopf, Residenzstr. 12b, Dresden-Blasewitz, Germany.
Korrosion und Metallschutz,
Verlag Chemie G.m.b.H., Bosestr. 2, Leipzig, Germany.
Kunststoffe,
J. F. Lehmanns, Paul Heysestr. 26, Munich, S.W. 4, Germany.
Laboratory,
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Machinery (London),
Machinery Publishing Co., Ltd., 51–52 Chancery Lane, London, W.C. 2, England.
Machinery (New York),
Industrial Press, 140 Lafayette St., New York City.
Manufacturers' Record,
Baltimore, Md.
Master Builder,
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Co-ordinated Playing of Team
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Inferior Skilled Individuals
will defeat an
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if
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Is to Be
Comparable to Progress in Other
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EDITORIALS

THE GREATER AMERICAN CERAMIC SOCIETY

There has been no questioning of the value that would accrue if, for the promotion and prosecution of ceramic research and education, there was in America one organization supported by all the varied ceramic industrial interests. The plan of organization and operation of this SOCIETY is that of centralized general activities with decentralized particular activities according to industries. The seven Divisions have their own officers, committees, and programs, some of them with special research funds.

It is but a small step for the trade associations to merge their product research activities in a special Division of the SOCIETY. The American Refractories Institute has decided to do this and the preliminary statement of the scheme adopted is as follows:

(1) For this purpose it is proposed that the American Refractories Institute be federated in and with the AMERICAN CERAMIC SOCIETY, both bodies to retain their present corporation identities. The present Refractories Division membership of the AMERICAN CERAMIC SOCIETY to be merged into the new Junior Associate classification of the American Refractories Institute.

(2) That on payment by the American Refractories Institute to the AMERICAN CERAMIC SOCIETY of the annual personal dues (now $10.00)

for each of its members, all members of the American Refractories Institute shall become members of the AMERICAN CERAMIC SOCIETY and shall have full voice in the affairs of said SOCIETY and receive all publications issued.

(3) The American Refractories Institute shall establish a new grade of personal membership suitably designated, for illustration, "Junior Associate," the annual dues of which will be the same as the personal dues of the AMERICAN CERAMIC SOCIETY (now $10.00).

(4) The Junior Associate members shall be individuals who are competent to fill responsible positions in ceramics and are interested in promoting the science and technology of the manufacture and use of refractories. Their rights and privileges of membership shall be restricted to those of active membership in the AMERICAN CERAMIC SOCIETY and to attendance at all Meetings to consider the science and technology of refractories production and use, and to receive the technical publications, such as *Bulletins* of the American Refractories Institute, *Journal*, *Abstracts*, and *Bulletin* of the AMERICAN CERAMIC SOCIETY, Bibliographies, etc.

(5) The privileges of the Refractories Fellowship at Mellon Institute shall be available only to the active and associate members of the American Refractories Institute as at present.

(6) The business affairs of the American Refractories Institute, the administration of the Refractories Fellowship at Mellon Institute and such other activities as shall be undertaken by the American Refractories Institute shall remain exclusively in the hands of the active members of the American Refractories Institute.

(7) The technical meetings of the American Refractories Institute shall be the meetings of the American Refractories Institute Division of the AMERICAN CERAMIC SOCIETY and at least one such meeting shall be held at the time and place of the Annual Meeting of the AMERICAN CERAMIC SOCIETY. Notices of such technical meetings shall be sent to all members of the Institute.

(8) All technical papers of the American Refractories Institute shall be published in the *Journal of the American Ceramic Society* with suitable and adequate acknowledgment of the origin of such reports and papers.

(9) The Secretary of the American Refractories Institute, at discretion of the active members of the Institute, shall serve as Secretary of the American Refractories Institute Division of the AMERICAN CERAMIC SOCIETY.

(10) All expenses incident to the editing, publishing and distributing of the *Journal* shall be borne by the AMERICAN CERAMIC SOCIETY. Ten per cent (an arbitrary figure) of the yearly AMERICAN CERAMIC SOCIETY membership dues shall be returned to the American Refractories Institute to cover expenses involved in the mailing of meeting notices, announcements, etc., which include the Junior membership.

This SOCIETY is an organization for and by the ceramic industries even though indirectly. The $40,000 per annum required to finance its activities come directly or indirectly from the industrial concerns. All of its activities are directed to improving methods of production

and quality of product. The AMERICAN CERAMIC SOCIETY in fact belongs to the ceramic plant owners. Why, through their appropriate Division, there is not a merger of that phase of trade association activities that deals with the production and use of ceramic products can be answered only in terms of lack of confidence and breadth of vision, neither of which is a guilt until the way for merging and the benefits resulting from merging have been made plain.

There is considerable in the art, science, and technology of any particular kind of ceramic ware production that has the same fundamental underlying factors as are involved in the production of all ceramic products in general. They have the same silicate reactions in mineral fusions, more simple or more complex, at higher or lower heats and carried to different degrees of completion. Even in the processing there are similarities. The humidity drier and the tunnel kiln are adapted to the peculiar requirements of each industry.

It remains a fact that the technical men in the varied ceramic ware factories have found it mutually profitable to be federated in the one SOCIETY. Carrying the proven fact a little further, it will profit the several trade associations to be federated in the production researches. This growing SOCIETY is theirs in which to merge their interests in the promotion of arts, science, and the technology of their ceramic ware production.

STATE CERAMIC ASSOCIATIONS

In this number is a statement by George A. Bole of the accomplishments and the plans of the Ohio Ceramic Industries Association.[1] This statement should be read by everyone who is interested in advancing the arts, science, and technology of ceramic ware production.

State universities are costing and will continue to cost a large amount of money, every cent of which is raised by taxation. These universities need direct and personal contacts with the producing and distributing concerns of their respective states if they are to adequately train the oncoming generation in the application of knowledge in up-to-date methods and facilities.

Universities have laboratories with a very considerable amount of equipment. These laboratories are maintained for the purpose of finding new facts and for determining the application of known data. These investigations are essential to collegiate education, for in no other way can the values, relations, and applications of things known be discovered.

[1] See this *Bulletin*, p. 382.

A progressive university keeps abreast with the latest developments by closely coöperating with the business leaders in the state. Naturally, no university can have working contact with all lines of business to the same extent; hence the universities work chiefly with those with whom it is easiest or most profitable to establish this contact. Following the paths of least resistance prevails in education as it does in all other human activities except where there is some one who is willing to make the physical and mental effort to extend his opportunities.

The busy manufacturer pays his taxes dutifully and delegates to others by public elections the task of looking after the needs and direction of his state university. Ordinarily it would not occur to him to work with the university in the solving of his manufacturing problems. Perhaps it is fortunate that all manufacturers in the state are not self-prompted at the same time to obtain the coöperation of the university, for the limited facilities and men available at the university would not permit this.

The greatest benefit will accrue to the university and to the industries when the industries are organized to make group contacts with the university.

In America the first essential was and still is a national society with a general research and educational promotion program. This is the agency the AMERICAN CERAMIC SOCIETY will continue to be. But the ceramic industries through employment of large production methods and the universities because of the rapidly increasing and more generally possessed fund of knowledge have come to that stage where a more intimate and more specific application to studies are required. This means that there must be a closer working relation between the universities and the ceramic industries and this cannot be had except by organized industrial units in each state.

In every state having a ceramic department there should be a state ceramic industries association with the single purpose of securing and using the research and educational facilities at its university in proportion to the relative industrial importance of the ceramic industries in that state.

Ohio has such a state association and it has been finding ways of increasing and using the research facilities of its University. The results could have been obtained in no other way.

PAPERS AND DISCUSSIONS

REPORT OF THE ENAMEL DIVISION STANDARDS COMMITTEE 1927–28[1]

Introduction

The work for the year has been carried out along the general lines of the previous two years. On March 29, 1927, the Committee met at the Bureau of Standards in Washington to study and plan its program. Later circumstances have made it impossible for the individual members to devote the anticipated time to the work and many of the plants to whom the Committee has appealed for coöperation have not responded as desired, so progress has been hampered. The Committee has taken the position that its function is to study tests that come to its attention rather than to originate tests itself.

Subjects under Investigation

(1) Flotation of Enamels The outstanding step in connection with this problem was the publication of a technologic paper by the Bureau of Standards on "Controlling the Consistency of Enamel Slips."[2] This work embodies the application of the principles of plastic flow which have been attracting interest for the past several years. The use of the suggested scheme for control of enamel is commended to the industry in the hope that therein may be found a workable plant test for the properties desired in enamel. At least one plant has been able to determine for several of its enamels characteristic plasticity graphs which have been used for comparison in cases of poor behavior of slip.

(2) Opacity So far as has been learned there has been no general use of the reflection gage suggested in the report of last year.[3] A paper on the present program by a member of the Committee bears on the general subject of opacity.

(3) Raw Materials The attention of the Committee has been called to the fact that producers of certain raw materials, particularly feldspar, do not use the same terminology in expressing the results of a screen test for fineness. In some cases the fineness is stated in terms of the finest screen through which all of the material will pass; others state the fineness in terms of the finest screen which retains not over a certain specified per cent of the total material. The Committee has no definite suggestion to make at the present time but hereby calls the attention of purchasers to the above difference in the use of the fineness figures.

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[1] Received October 8, 1928.

[2] *Jour. Amer. Ceram. Soc.*, **10** [12], 970–94 (1927); Bur. Stand., *Tech. Paper*, No. 356.

[3] *Bull. Amer. Ceram. Soc.*, **6** [9], 260 (1927).

Several requests for specifications for raw materials have been received and there is an increasing realization of the importance of reliable and uniform raw materials.

(4) Control Tests Last year it was stated that there would appear later as Appendix D the results of a circular letter submitted to members of the Division. This material did not become available then and is submitted, therefore, as Appendix A of this Report. The Committee has endeavored to learn further from members of the Division their opinions as to the tests for fineness and deformation which were adopted as Tentative Methods last year. As Appendix B, appear notes regarding the determination of fineness and the results of a circular letter on deformation are given as Appendix C. One member has done considerable work on a combination of one of the tests suggested in Appendix A and the plate pick-up method of determining consistency of slip given as Test 8 in the report of 1925–26. The results of this work are given as Appendix D of the present report. The Cross-Bending Test, 9 in the original list, a preliminary investigation of which was covered in Appendix C of last year's report, has aroused considerable interest and, in addition to the work done by the Committee, one firm has made a definite contribution to the development of this method of testing the strength of enamel as applied to the metal. Progress along this line is covered in Appendix E of this record.

(5) Expressing Enamel Compositions Of the several "additional problems" listed in the report of last year, the one named herewith was considered as worthy of attention though recognized as not promising of early solution. One member of the Committee was assigned the task of presenting in concrete form various possible methods of expressing compositions. Such a statement is presented as Appendix F.

Conclusion

The Committee regrets that it has nothing to offer as additional tentative tests this year and that it cannot as yet recommend that either of the tentative tests approved last year be approved as standard. An effort has been made to add to the records valuable information regarding these and other problems and anticipates much further benefit from the discussion of the various phases of the work which is to take place in connection with the presentation of this Report. The Committee feels that a carefully edited record of such discussion should become available to the Committee and the Division as a whole.

Respectfully submitted,

E. P. Poste, *Chairman*,
J. E. Hansen,
W. N. Harrison,
B. A. Rice

APPENDIX A

Control Tests Questionnaire, 1926–27

Following up the work of the Committee during 1925–26 on control tests, a circular letter was sent to each member of the Enamel Division. Definite questions were asked in this letter designed to bring out the following major points:

1. How many members were using any or all of the control tests as outlined in the report of this Committee for 1925–26 and, of the users, how many started the tests since their publication; this latter fact being a possible indication of the value of the Committee's efforts in compiling a list of methods.

2. Criticisms of the methods as published and reasons for or against their use.

3. Modifications of the present tests and the development of any new methods.

That there is generally very little response to a questionnaire of this kind is regrettable but true and the only manner in which this last letter could have been considered an exception was the fact that there were even fewer answers than usual. A brief analysis of these replies indicate that:

1. Test No. 1, the analysis of steel and cast iron, is not used extensively.

2. Test pills, Test 2, are not used as much as direct titration, Test 3, for determining the strength of cleaning, pickling, and neutralizing baths. This assumption is probably erroneous. The replies to the original questionnaire, 1925–26, showed a majority of plants to be using the pickle pills. Either these have changed or, what is more likely, most of the replies to the present questionnaire were received from plants maintaining chemical laboratories so that the titration method would have the preference due to its greater accuracy. When the proper apparatus and supplies are available, the titration method is more accurate and nearly as rapid as the pills. One method or the other was in use at each plant from which replies were received.

3. Test 4 (analysis of raw materials), is considered essential for some materials. In general, this analysis is supplied by the dealer.

4. Test 5 (deformation cone test), was considered satisfactory for development work but some doubted its practical value as a method of plant control.

5. Test 6 (screen test), is much more generally used than Test 7 (settling method), for determining the fineness of ground enamel. Some of the objections to the latter method were that it required too much time, that it was too technical for the average mill-room man,

and that the mill additions sometimes interfered with proper interpretation of results.

6. Test 8 (weighing of a dipped standard sheet of metal), is in general use for determining the proper consistency of the enamel in the dipping tank. No objections to this method were given.

7. Test 9 (cross-bending of the enameled strips) is not in general use and seems to be regarded by the majority as of value only in development work and not for plant control.

8. Test 10 (impact test) is covered by the same statement given above for Test 9. Only one firm reported this as a factory control test.

Some new tests were suggested as follows.

Method of Determining the Strength of Alkali and Acid Baths

Cleaner The active base of cleaners is essentially sodium oxide, Na_2O, and the determination of the amount of this material in the cleaner will serve to indicate its strength. A simple and sufficiently accurate method is made possible by the use of standard hydrochloric acid made from Fixanal, marketed by Pfaltz and Bauer of New York City.

A factor solution is made up so that 1 cc. of acid is equivalent to 0.1% Na_2O in a 10 cc. sample of cleaner. This is accomplished by making a $^1/_3$ normal hydrochloric acid. A Fixanal bottle with acid to make 1 liter of normal solution will make 3 liters of $^1/_3$ normal. The acid is prepared, therefore, by diluting to 3 liters the acid contained in a normal Fixanal hydrochloric acid bottle.

The 10 cc. sample of cleaner can be taken in a pipette or, very conveniently in the 10 cc. copper dipper furnished with the capsules for testing acid and alkali baths in pickle rooms. Methyl orange is used as an indicator.

As an example of the test, suppose that the 10 cc. sample of cleaner is neutralized by 22.5 cc. of the factor acid. Then the strength of the cleaner is 2.25% Na_2O.

Neutralizer Na_2O is usually the basic material but is present in much smaller quantities than in cleaner solutions. A factor solution is prepared so that 1 cc. is equivalent to 0.02% Na_2O in a 10 cc. sample. The $^1/_3$ normal acid used for the cleaner solution is diluted to one fifth of its strength for this. To prepare 1 liter, to 200 cc. of the $^1/_3$ normal acid used for the cleaner test add 800 cc. of water. The method is similar to that used for the cleaner. A reading of 15.2 cc. would indicate 0.30% Na_2O.

Acid A convenient factor solution for determining the amount of H_2SO_4 in a sulphuric acid bath is one for which 1 cc. is equivalent to 0.2% H_2SO_4 in a 10 cc. sample. A reasonably accurate solution may

be prepared by dissolving commercial soda ash in water. A Na_2CO_3 solution containing 21.5 grams per liter is required. This is closely approximated by dissolving 3 oz. in one gallon of water. Methyl orange is used as the indicator. The sample is measured as for the cleaner or neutralizer, the dipper being used if the acid is hot when being measured. A reading of 12.8 cc. would indicate a strength of 2.6% H_2SO_4.

These tests have been devised to give the required accuracy for shop control without the necessity of an analytical laboratory. The apparatus includes a burette, measuring device (10 cc. of pipette or dipper) and a few small beakers or flasks. Table tumblers will do nicely. A graduate holding one liter will also be needed. The standard strength hydrochloric acid can be purchased for less than one dollar per bottle. Soda ash from the mixing room can be used. Methyl orange indicator can be obtained from a drug store at little expense. Tap water is satisfactory for preparing the solutions.

The tests are not designed as finely accurate. The gravity of the solutions being tested is taken as unity. In the calculations of the factor solutions approximate figures have been used. But the results are sufficiently accurate to serve for routine shop control.

Method of Determining Gravity of Enamel Slip

A copper flask is so made that it holds one liter at a point near the center of a rather long neck. To calibrate the flask exactly one liter of water is poured into it and the level of the water located as closely as possible on the outside of the flask. The water is poured out and a 1/4-inch hole is drilled in the side of the neck so that the lower edge of the hole will be approximately at the liter mark. The flask is then carefully weighed and filled with water to above the hole in the side of the neck. The excess runs out till the level of the bottom of the hole is reached. The flask is again weighed. Subtracting the original weight of the flask gives the weight of the water. If the flask is right the weight will be 1000 grams. If the weight of the water is less than 1000 grams the volume is too small. By means of a blunt stick and a hammer the bottom of the flask can be dished out and the volume increased. If the weight is over 1000 grams the volume is too great and can be reduced by dishing in the bottom of the flask and tapping with a hammer. In this manner a point can be reached at which the flask will hold exactly one liter.

For testing enamel the empty flask is tared on the scales and then filled with slip. The additional weight necessary to balance is the weight of the enamel and expressed in kilograms is the gravity. For instance if the weight to balance is 1736 grams the gravity is 1.736.

By having a set of flasks made with a funnel on top of the neck filling is easier and the several flasks can be brought to the same weight by shearing off metal from the funnel of the heavier ones. Then a single tare weight can be made to balance all of the flasks.

The flasks should be tested with water from time to time and the bottoms dished out or in as may be necessary.

Cone Screen Test[1]

A screen made up into the shape of a cone is used for a rapid method of determining the fineness of ground enamel. The size of the cone is optional, the one recommended having a diameter of 3 inches at the base and a height of 5 inches. It may be constructed of whatever mesh screen may be desired, but this mesh should be such that a small residue will be left in the apex of the inverted cone. This residue, instead of being weighed, is calculated on a calibrated scale attached to the side of the cone, the height of the residue in the screen being a measurement of the fineness.

A standard quantity of enamel from the mill to be tested, for example a half pint, is poured slowly into the cone which is held under a stream of water running gently from a water tap or from a water hose. All the enamel is transferred to the cone by rinsing out the measure and is washed through the screen. The residue is washed down into the point of the cone, the amount being determined by reading its height on the calibrated scale on the side of the cone.

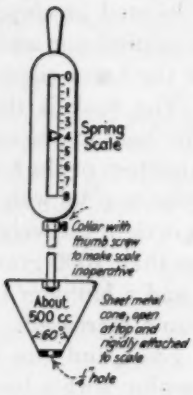
Spring Scale
Collar with thumb screw to make scale inoperative
About 500 cc
60°
Sheet metal cone, open at top and rigidly attached to scale
¼" hole

FIG. 1.

In case the sample taken from the mill contains any large amount of coarse unmilled particles such as may be packed around the mill head, it will be necessary to remove these by passing the sample through a coarse screen, such as 30- or 40-mesh, before introducing it into the cone.

Measuring Consistency of Enamel Slips

Of several additional tests submitted for the measurement of the consistency of enamel slips, the one given below was considered by the Committee to offer the best possibilities.

A self-explanatory diagram of the apparatus is given in Fig. 1. A reading of the spring balance is taken to get the weight of the cone. The indicated thumb nut is tightened to make the scale inoperative and the cone is then immersed in the enamel slip until it fills. The cone is removed from the enamel

[1] This method, merely outlined here, is given in detail on pages 7 to 9 of *The Enamelist*, April, 1927.

and the length of time required for the slip to pass through the opening at the bottom is noted. After draining has ceased, the thumb nut is loosened and the weight of adhering enamel is determined by the difference between the reading of the spring balance now and before the cone was immersed in the enamel slip.

This test gives two results, the time of flow of the slip through a given orifice and the weight of adhering enamel as in Test 8. It is probably more rapid than Test 8 but may lack accuracy due to the use of a spring balance and the small area in contact with the slip.

Conclusions

Conclusions based upon the results of this survey have been given in detail earlier in the report and will not be repeated here. The Committee grants the probability of erroneous deductions from the small amount of data available and can only plead the excuse of lack of coöperation and interest on the part of the members of the Enamel Division.

APPENDIX B

Notes on the Sieve and Settling Tests For Fineness of Enamel

Several points with regard to the work reported last year have been called to the attention of the Committee.

Method of Taking Sample There is a difference in opinion as to whether the sample for the screen test should be taken by weight or volume. One suggestion is that the method should definitely state that the sample is "wet weight" and should indicate about what per cent of water is meant. Against this we have been asked to consider taking a sample that would correspond to 100 grams of frit. An entirely different scheme is taking a sample of a definite volume. None of these suggestions is free from certain fundamental errors. Unless the amount of water in relation to other materials in the mill charge is the same within close limits, errors will result by any method of taking the sample unless it be by basing it on 100 grams of frit and this presupposes a careful regulation of the water content, and possibly a different weight or volume of sample for different enamels, varying with the mill charge as a whole. With well standardized mill charging with particular reference to the amount of water added, a given mill charge should produce enamel of a uniform gravity from mill to mill and, in this case, either a sample of uniform weight or volume would assure the proper fineness control.

One member has made a set of curves showing the relation between gravity and frit content of slips for various enamels. By the use of

these curves he takes a sample by volume known to contain 30 grams of frit. The test is made with this sample by the settling method.

Use of Screen Test for Very Fine Enamels

One manufacturer who has attempted to use the screen test for fine white spraying enamels states "that it is inapplicable . . . . for the reason that they are so fine that almost none remains on the 200-mesh screen." Against this another has suggested the substitution of a 325-mesh screen for fine enamels. Certainly an enamel ground so fine as all to pass the 200-mesh screen could not be tested accurately by the method as stated. The use of the 325-mesh might be feasible as to the accuracy of the test but it would be slow to run and the screen is weak and very expensive.

Relation of Fineness and Degree of Fritting

Another criticism of the screen test which has been suggested to the Committee is the possible effect of various degrees of shattering of enamel during fritting on the distribution of fineness in milled enamel. The thought is that, depending on how thoroughly the enamel is broken up on fritting, the relation between the total amount of coarser and finer particles might vary and so a given indicated fineness by the screen test would not necessitate a like general fineness distribution in a given enamel from one grind to another. How effective this factor is has in no way been determined. If the effect is appreciable it is quite probable that it would also call for consideration in the settling test.

Settling Test

A further observation with regard to this method of testing is the statement that "with fine white enamels the sediment line is more easily distinguished as the enamels become finer." Another user gets a satisfactory result by adding 1% of a blue milled enamel to the sample of white being tested.

One party at least has attempted to apply the settling test to dry-process enamels. His observations are as follows:

Sodium silicate was not used but since the function of this material is the deflocculation of the clay and there was no clay in this enamel, its addition was not thought to be necessary.

The peculiar thing which was noticed was a difference in the manner of settling. Certain enamels would settle normally, that is, immediately after shaking the coarser particles would begin to settle to the bottom and this bottom layer would gradually increase in height while the upper layer would gradually clear up. With certain batches, however, of enamel of exactly the same composition, from the same mill, the mode of settling would be entirely different. After shaking, the enamel would begin to subside as a unit. In other words, the water would become absolutely clear at the top and this clear layer of water would gradually get deeper but there would never be any layer of the coarse particles at the bottom of the tube. The settling in fact would be more like that of pure clay.

Of course, on an enamel like this no conclusion could be drawn as to its fineness. It is presumed that this would never happen with the finely ground wet enamel but it happens so frequently with coarsely ground enamel that the idea of the settling test had to be given up.

In reply to this statement one investigator made the following statement.

In the case of the gradual settling, leaving a clear solution above, the colloidal particles of enamel were flocculated on or about the coarser grains. It is difficult to know why the different batches should be different, but the fact remains that they are, and it would not be surprising, if this is where the difference lies. If this hypothesis were correct, then the mode of settling should be changed by the addition of a deflocculating agent. A small addition of NaOH might effect the deflocculation, although this may not be true. Even assuming the above explanation and suggested remedy to be correct, there would still be some objection to the test, because of variation in the *degree* of flocculation. If a constant amount of NaOH were added at each test, there should be some difference in behavior of the samples due to difference in initial conditions, although this might prove to be negligible.

APPENDIX C

Notes on Tentative Method for Deformation Temperature of Enamel

During the past year no further work was done by the Committee on this test but an effort was made to determine from others their opinion as to certain points in connection with the method.

It was agreed that within reasonable limits the grain size of the enamel does not affect the deformation temperature. The size of the grain is thought to have more affect on the ease of molding the cones than on the rate or temperature of deformation.

It is agreed that the angle at which the cones are mounted should be changed from 15° from the vertical to 8°, the latter angle conforming to recent specifications of the Bureau of Standards for mounting Seger cones.

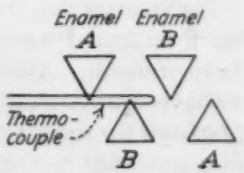

FIG. 2.—Method of placing 4 cones in furnace.

When the cones are first placed in the furnace there is a resulting drop in temperature. If the time-temperature curve is to start at 800°F, the time reading should start when 800° is again reached after recovery from the initial drop to a lower temperature.

Some users of the method have changed the rate of heating from that given in the specifications to one that is much slower. The slower rate of heating seems preferable for making accurate determinations but

present rate of heating seems satisfactory for the more comparative work of factory control and is, of course, more rapid.

Several have successfully run four cones at a time instead of two as shown in the specifications. The arrangement is shown in Fig. 2. In this way the deformation temperatures of two enamels, instead of one, are obtained with each run. Those who have tried the method prefer it and those who have not actually used it have offered no criticism of the change.

APPENDIX D

Pick-up and Specific Gravity Tests for Enamel Slips

Test 8, Report of the Enamel Division Standards Committee, 1925–26, Appendix D is stated as follows:

A flat piece of cleaned steel, approximately 2 sq. ft. in area, is taken as a standard. It is weighed and dipped in enamel which is known, by trial, to have the proper set-up. The piece is allowed to drain, and is weighed again. The difference in weight before and after dipping is the weight of enamel on the piece. This amount of enamel is adopted as the standard desired for future dipping operations. The piece of steel is then cleaned and set aside. When a fresh batch of enamel is to be set up, the above process is repeated, using the same piece of steel and the enamel is varied until the standard amount of enamel adheres evenly after draining.

This test is apparently in quite common use but as far as the Committee was able to learn, no effort had been made to standardize it in terms of condition of surface of test piece before dipping in ground coat or angle of repose during draining. A certain amount of work has been done on these phases of the test.

Surface of Test Piece

Preliminary use of unenameled test pieces fresh from the pickle room indicated various irregularities the elimination of which seemed to be difficult. Assuming uniform pickling, it was not an easy matter to have always available fresh clean test pieces. Those that had been prepared for some time were liable to become rusty or otherwise altered in a way that would affect the adhesion of the enamel. The essential requirement of the test is that pieces of a given area pick up the same weight of enamel of a given consistency. It is not necessary that the weight picked up should be the same as would be picked up by a piece of pickled ware of like area. Hence it is not required that the surface condition of the test pieces be identical with the surface condition of commercial ware going through the ground coat tank. Based on the above conclusions it was decided to use test pieces that had been given

a regular coating of ground coat and fired. The same pieces were thus suitable for testing either ground coat or cover-coat enamel.

The test as stated involves a test piece 2 sq. ft. in area. It seemed well to experiment with test pieces of two sizes. The smaller was made 12 inches square and the other 17 inches square, the latter having an area of 289 sq. in. At least one firm is known to be using two test pieces of these dimensions.

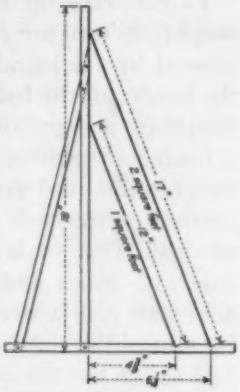

FIG. 3.—Plate draining rack.

Angle of Repose

The Committee made some effort to determine the angle of repose used in this test. Some users apparently hold the piece approximately vertical in the hands during draining; some lean it against a convenient support with no particular reference to angle; while others use a specially constructed rack making sure of a constant angle.

A firm apparently using the test satisfactorily employs a rack of such dimensions that with the 12-inch square plate the bottom is offset a distance of $4^3/_8$ inches while with the 17-inch square plate the offset is $6^1/_4$ inches. These two cases give essentially the same angle of repose, 21° 31′ with the vertical.

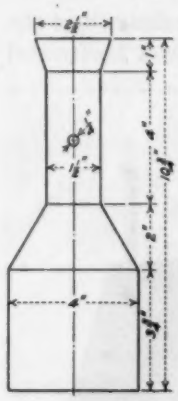

FIG. 4.—Specific gravity bottle (inside dimensions).

In accordance with the above, a rack was constructed so as to make possible the use of either plate at its proper position. The essential features are shown in Fig. 3.

Specific Gravity Test Apparatus

Appendix A of this Report contains the statement of a simple method of determining the gravity of enamel slip which has found favor with several plants. It happens that the equipment used serves very well in connection with the pick-up test under consideration; the tests are therefore conveniently made together and may well be discussed in connection with each other.

The essential features of the gravity-test apparatus are a copper bottle calibrated to hold 1000 cc. and a set of balances capable of weighing a load of 3 kilograms to an accuracy of 5 grams. The copper bottle can be made by a sheet metal worker from the sketch in Fig. 4.

Several of the statements being made with regard to this test are in a way a repetition of the original statement of the method in Appendix

A, given here to render this portion of the Report complete within itself.

To calibrate the bottle it is placed on one side of the balance and weights to tare are placed on the other side. Then the weights are increased by 1 kilogram and water (approximately 70°F) is poured into the bottle till the balance comes to equilibrium. The level of the water should come approximately half way up the neck of the bottle. A mark is made on the outside of the neck at the level of the water inside. The water is removed and a $^1/_4$-inch hole is so drilled in the neck that the bottom of the hole corresponds to the level of the water previously marked. The bottle is again tared on the balance, filled to the overflow hole with water and weighed. If accurately calibrated the bottle will hold 1000 g. of water. If not the volume can be adjusted by denting the bottom of the bottle in or out as required.

A set of bottles can be brought to a common weight by trimming metal from the funnels of the heavier ones till they all weigh the same. It is also convenient to prepare a tare weight which will balance any one of the bottles.

Testing of Slip

One of the copper bottles is placed on one pan of the balance and the tare weight on the other pan. A test plate is placed in a horizontal

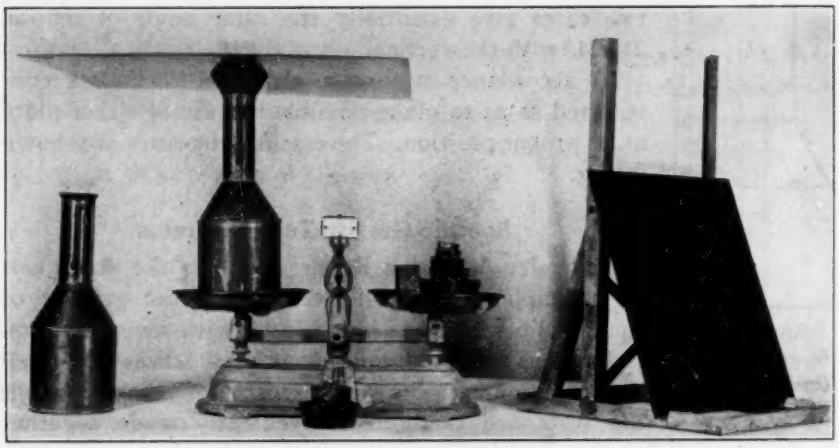

Fig. 5.—Slip testing apparatus.

position on the top of the bottle and weighed by adding weights to the tare pan. The piece is then dipped in the enamel to be tested, immediately placed in position on the draining rack and as soon as draining has ceased, again placed on the top of the bottle on the balance. The additional weight required to balance gives the wet pick-up

for the test piece being used. Some users dry the plate and reweigh, thus determining the dry pick-up.

The bottle is then filled to overflow with slip and weighed. The weight in kilograms in addition to the tare required to balance gives the specific gravity of the slip.

The entire apparatus used in the combined test is shown in Fig. 5. A specific gravity bottle is shown on one side of the balance and the tare weight on the other. On top of the bottle is the 2-sq. ft. plate. On the pan with the tare weight are weights to balance the plate on the bottle. Nearby is the draining rack with the 1-sq. ft. plate in position; also a bottle the top of which has been trimmed down to bring the bottle to the desired weight.

If plasticity tests are to be made, the enamel in the bottle affords a convenient sample to be taken to the plasticity apparatus if it is not desired to make the test near the dipping tank.

Pick-up Test Data

When this method of testing was being studied a series of tests was made on ground-coat dipping tanks to determine (1) effect of size of test piece on pick-up per unit area, and (2) relation between size of ware for which enamel was set up and pick-up per unit area.

(1) Tests were made by using both 1- and 2-sq. ft. test pieces in the same enamels, draining each in its proper position on the rack. The pick-up for the 1-sq. ft. piece averaged 72.2 grams per sq. ft. and that for the 2-sq. ft. piece, 60.9 grams per sq. ft. Apparently in a given enamel the pick-up per unit area varied inversely with the size of the piece.

(2) In enamel set up for dipping small pieces the 1-sq. ft. plate gave an average pick-up of 66 g. per square foot while the 2-sq. ft. plate gave 61 g. per sq. ft. In enamel prepared for dipping larger pieces the 1-sq. ft. piece gave an average figure of 69 g. per sq. ft., while the larger piece gave 63 g. per sq. ft. Assuming that the smaller piece should show about the right pick-up in enamel properly adjusted for small ware and that the larger piece should show a proper pick-up for enamel adjusted for larger ware, the figures of 66 and 63 g. per sq. ft. were taken as closest to the proper value. The choice of 65 g. per sq. ft. was thus arrived at as being the proper pick-up on all ware. Subsequent data obtained by using the small and large test pieces in testing enamels prepared for the two classes of ware have proved the value of 65 g. per sq. ft. to be a very reliable figure for the shop involved.

Tests made by placing the plates at different angles during draining indicated the importance of using a constant angle for obtaining comparable results.

Experience has also shown that with a given enamel prepared in the

same way as to mill additions, fineness of grinding, and age, the specific gravity will run quite uniform for enamel properly adjusted for a given type of ware if the surface condition of the metal is also constant. The method of determining gravity outlined is of sufficient accuracy to be of use in this connection.

Seven bottles of the above design have been in use for about 15 months. Initially they were all adjusted to hold 1000 ± 2 g. of water at 70°F. They were recently checked and found to hold from 995 to 999 g., the average being 997 g. Taking the average initial capacity at 1000 g. the average loss in capacity is 3 g., the maximum 5 g. Applying these figures to an enamel with a true gravity of 1.850, the average indicated gravity would be 1.845, and the lowest 1.840. These errors are not outside of the probable range of accuracy of the test as a whole and are not sufficiently grave to have a definite bearing on the properties of an enamel. It is significant that all the bottles lost in capacity. Obviously they should be checked at intervals and adjusted as found to be necessary.

APPENDIX E

Further Studies of the Lindemann-Danielson Cross-Bending Machine

Owing to the failure of the Committee to publish a detailed drawing of the modified machine presented in the report of 1926–27, no additional machines were constructed in time to make available comparative data of the type desired. Late in the year the Titanium Alloy Manufacturing Company became sufficiently interested in the matter to offer to make drawings of the machine and information was furnished them to make possible a detailed drawing which has been checked with the machine and found to be correct. This drawing is reproduced as Fig. 6. Preliminary to building their own machine the above company made certain changes in details and the result is shown as Fig. 7. The Committee is greatly indebted to this company for their interest in the test and the service rendered the industry through the use of these drawings. It is to be hoped that several companies will now be in a position to make machines and assist in the thorough development of the merits of the test.

Index of Failure

In connection with the presentation of the report of last year there was some discussion as to whether the first crack or the first actual jumping of enamel should be taken as the failure of the enamel and the end point of the test. In a communication to the Committee W. L. Lindemann, one of the originators of the test, made the following comments:

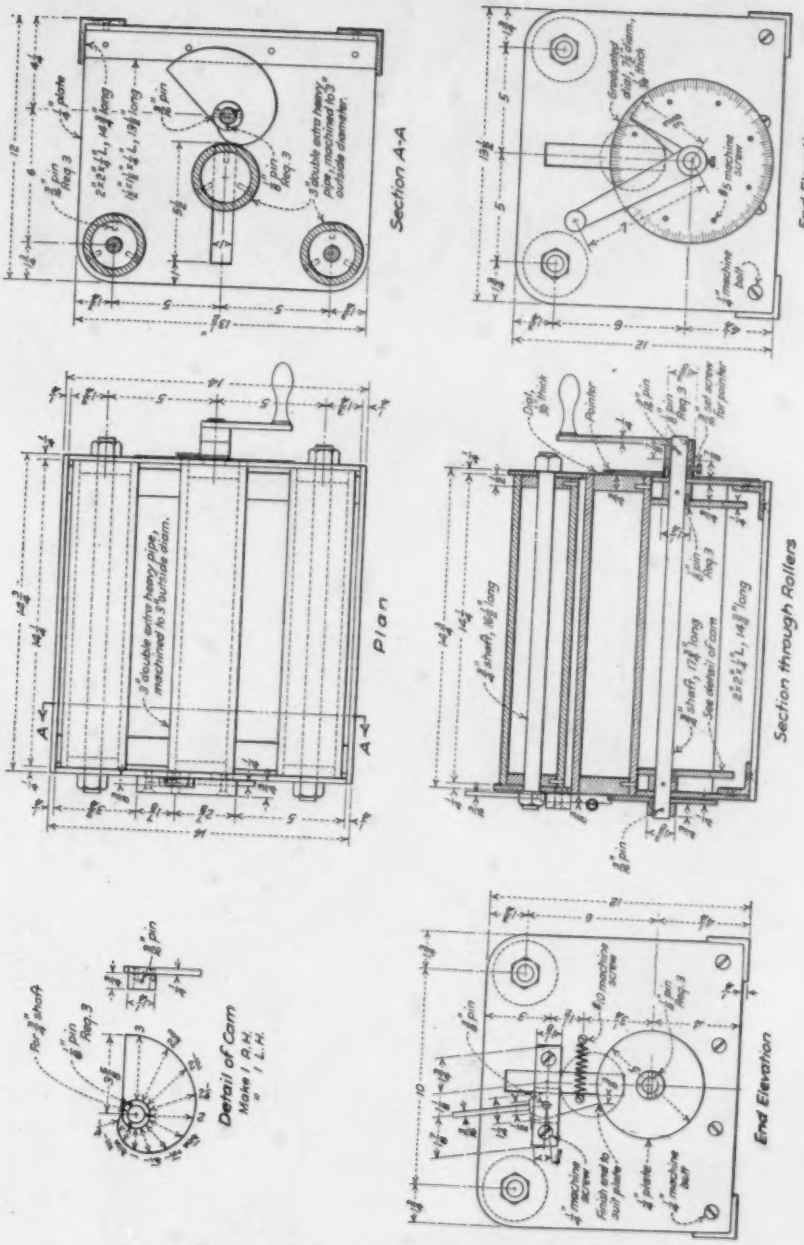

FIG. 6—Cross-bending testing machine.

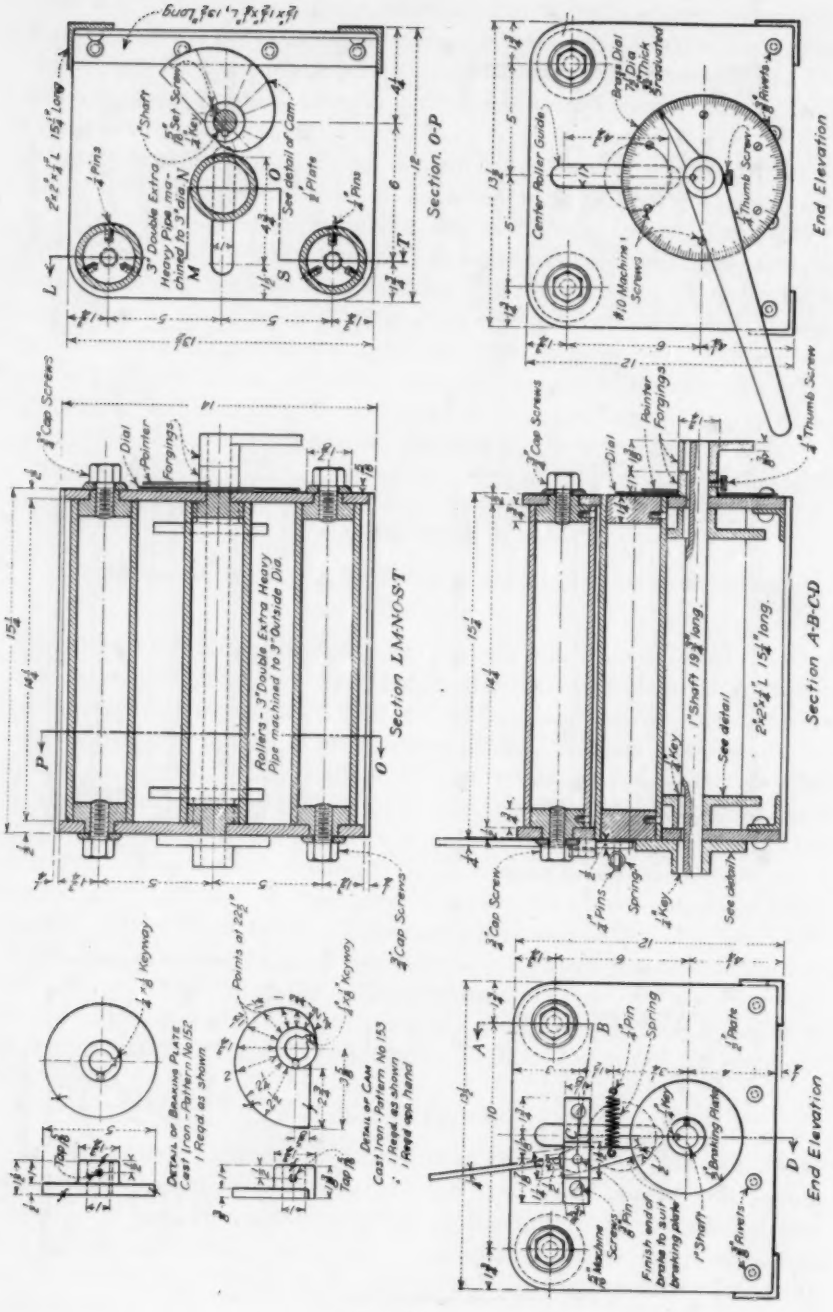
Section O-P
End Elevation
Section LMNOST
Section A-B-CD
End Elevation
Detail of Braking Plate
Cast Iron - Pattern No 152
1 Reqd as shown
Detail of Cam
Cast Iron - Pattern No 153
1 Reqd as shown
1 Reqd opp hand
Roller - 3" Double Extra Heavy Pipe machined to 3" Outside Dia
1" Shaft 19½" long
2½"x2½"L 15½" long.
See detail
Finish end of Brake to suit braking plate

FIG. 7.

Regarding the question of the interpretation of the test, both the first crack and the final failure of the enamel should be observed. In the majority of cases the first crack is a criterion as to the strength of a piece, but quite often pieces that crack first have the enamel hang on strongly for a much longer period than some other samples that did not crack until later but had the enamel flake off almost immediately after cracking. So for full information it is wise to record both the first cracking of the enamel and the ultimate failure.

With regard to the same point R. R. Danielson, co-originator of the machine, has expressed himself as follows:

Two different properties of the enamel are indicated by the first visible crack in the enamel and the first appearance of flaking. The first crack is a measure of the tensile strength of the cover enamel, while the first flaking is a rough measure of the adherence of the cover enamel to the ground coat. Until considerable more work has been done on the relations of ground coats to cover coats your Committee should take the first visible crack as the end point.

In making a large number of tests several observations have been made with regard to the nature of the failure and the interpretation of results. If narrow strips (2 inches wide) are being tested it will be noted that unless special care in the making of the pieces has been taken there will be slight beads at the edges where the enamel is a little thicker than in the main portion of the width of the sample. In

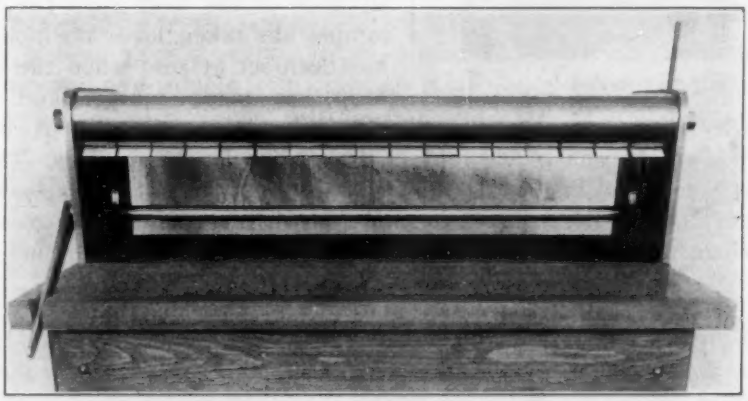

FIG. 8.

such cases a fine crack will often start at such beads well in advance of a crack in the center of the strip and it is difficult to decide whether or not to record this first cracking of the bead as the actual "first crack" of the enamel. Some judgment has been found necessary in individual cases. After cracking has definitely taken place two types of progressive failure have been noted. In the one case additional cracks appear

approximately parallel to the first and it may be that the test piece gradually bends around the middle roller to the limit of the travel without any enamel jumping out of place. In the other type, the cracks are not as definitely parallel and quite soon after the initial cracking flakes of enamel of some area come loose and fly off or at least separate themselves from the enamel beneath. So far as the studies under consideration have gone it is very difficult to decide when to record anything but the first crack and then some doubt may occur with reference to the effect of beads at the edge as outlined above. Hence the only quantitative values that have been recorded are for first crack.

An observation that is of definite value results from throwing the machine to full deflection after the pieces have all failed. The nature of the results thus produced indicates much as to adhesion to metal, fit of cover to ground coat, and the like.

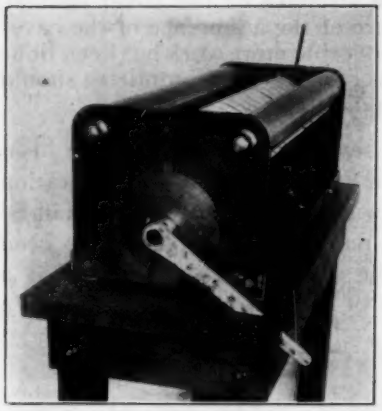

FIG. 9.

Start of Test

In making the tests during the past year a slight change suggested in the report of last year has been made. Instead of starting the steady advance of the load after the last sample has taken load, the pointer has been set at zero when the first strip has made contact and the pointer advanced one point per minute throughout the test. As each individual strip has made contact the reading has been taken. These initial readings subtracted from the final readings at which the several strips have developed first cracks have been taken as the deflection to produce first crack. The values are obviously in hundredths of an inch.

Experimental

Additional data as to the accuracy and value of the test have been obtained and typical values are being included in this record. It should be remembered that in last year's report two different enamels had been tested several times by different operators and the average result for one enamel was 33 and for the other 39.

In connection with the experimental use of a certain enamel in the shop, 2-inch test strips were prepared at three different times and tested with average results of 35, 36, and 35. Samples of commercial ware 12 inches wide on which this enamel had been used were tested at two separate times with average results of 33 and 35. The ware

seemed to be of a good quality for the enamel involved. At another time this same enamel was showing undue weakness in the shop and two tests gave average results of 24 and 28. These data indicate a reasonable check between 2-inch strips and commercial pieces of seemingly good quality while commercial pieces known to be poor in strength tested well below the others.

In another case a series of ground coats was being studied without cover coats being applied. The entire set of samples gave results running from 23 to 68. Those which proved to be far superior to the others averaged 38 while the poorer ones averaged 28.

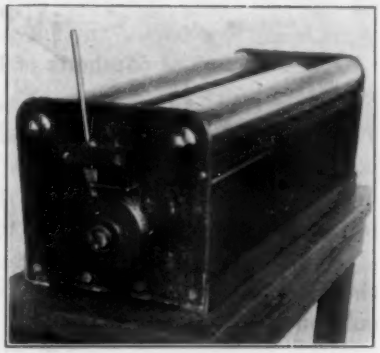

FIG. 10.

In a series of experiments with a given enamel, strips from five different lots were tested. In each case 6 samples were averaged for final results. The figures were 29, 31, 30, 30, and 30. From these values the enamels were taken to be of essentially the same strength.

An opportunity to compare two enamels of definitely different properties gave results of 32 and 34 for one enamel, 49 and 50 for the other. In each case the values are the average of three tests.

At a time when a certain lot of commercial ware was apparently giving excessive trouble from chippage it was at first thought that the enamel involved was very brittle. Samples were made and found to

FIG. 11.

average above the accepted figure for the enamel involved. Further investigation proved the trouble to be from a source entirely independent of the enamel itself.

These several cases are cited to suggest the possible utility of this test in experimental and commercial applications.

NOTE: Since the preparation of the above text The Titanium Alloy Manufacturing Company has had considerable experience with the machine constructed for their own use and have made machines for several other concerns. Four photographs of their own machine are reproduced herewith as Figs. 8 to 11. The manner in which this Company has coöperated with the Committee is very commendable and greatly appreciated. Such an interest on the part of several organizations would add greatly to the progress of the work being done.

APPENDIX F

Report of Methods of Expressing Enamel Formulas

One of the problems considered by the Committee during the year 1927–28 dealt with the methods of expressing enamel formulas. It was the hope of the Committee that some definite type of expression might be agreed upon and that the Enamel Division might go on record in insisting that all data presented in our meetings be in this form.

To that end the following methods of expression were submitted to the members of the Committee and to other interested parties for discussion:

(A) Raw Batch Formula Substitutions or replacements of one material for another in the raw batch formula on a pound for pound basis are seldom logical for often the melted weight of the batch changes considerably and confusion results. The raw batch in itself, moreover, does not indicate clearly the exact chemical nature of the frit.

(B) Molecular Formula The molecular formula represents the theoretical chemical nature of the enamel frit as no other method does, but it lacks information as to the source of the various oxides. It also is little understood by the nontechnical man. As a further objection, any variation, such as a study on the increase or decrease of such items as borax or feldspar, calls for a somewhat complicated recalculation. If we wish to vary soda ash, we can substitute Na_2O for some other RO oxide without extensive recalculation, but unless *substitution is* made, recalculation is absolutely necessary.

(C) Constant Melted Weight This method has its advantages, but often leads to illogical substitutions such as replacing (*a*) feldspar by boric oxide, (*b*) feldspar by lead oxide, (*c*) feldspar by cryolite, etc. One member of this Committee remarked that the imposed necessity of maintaining a constant total melted weight confines us to a very illogical set of requirements.

Early discussion of the status of this problem seemed to bring out the following as requirements for the expression of an enamel formula:

(1) Formula should stand for a definite enamel frit. (2) Ratio of each constituent to whole should be apparent (*a*) either by arithmetical gravimetric units, or (*b*) by molecular ratio.

It was further suggested that the formula should (1) express the ratio of acidic to basic elements; (2) a molecular formula, *letting total SiO_2 be unity;* (3) a molecular formula, *letting Al_2O_3 be unity;* and (4) a molecular formula, *letting quartz SiO_2 be unity.*

Item 1 above is perhaps desirable but it is still doubtful as to whether the value of this information is made use of by any great number of enamelers. Items 2, 3, and 4 differ so little from the conventional type of molecular formula that is seems undesirable to complicate the literature with a new type, especially since any particular individual who may prefer this type may easily convert the conventional type of molecular formula into his preferred new type by the use of the proper factor. Item 4 is also objectionable in that occasionally a formula is found in which there is no quartz silica, the sole refractory being feldspar.

The consensus of opinion among the majority of those coöperating with the Committee to the extent of submitting written suggestions or criticisms is that at the present time it seems desirable to express the enamel formula in terms of raw batch weight in such a size batch that the melted composition will add to 100 parts. This method of expression indicates the source of all raw materials, the melting loss, as well as the theoretical melted composition.

The suggested method would permit of the expression of a formula as follows:

		SiO_2	Al_2O_3	K_2O	Na_2O	B_2O_3	Cryolite	CaF_2	SnO_2	ZnO	BaO
Borax	26.5				4.37	10.0					
Feldspar	35.3	24.40	6.00	3.35	1.40						
Quartz	5.6	5.60									
Sodium nitrate	8.0				2.93						
Soda ash	5.7				3.30						
Cryolite	5.0						5.0				
Fluorspar	5.0							5.0			
Tin oxide	9.0								9.0		
Zinc oxide	10.0									10.0	
Barium carbonate	12.4										9.65
	122.5	30.00	6.00	3.35	12.00	10.0	5.0	5.0	9.0	10.0	9.65

Total 100

From the above data the theoretical coefficient of expansion can then easily be figured and any one so minded can proceed in a calculation of his particular pet type of formula, be it the empirical molecular type or otherwise.

ACTIVITIES OF THE SOCIETY

THE BIG CERAMIC WEEK

Chicago, February 4–9, Inclusive

Plans

On October 14 one more than one-half of the exposition booths had been sold insuring success for the Exposition.

One and one-half fare on the certificate plan has been granted by the railroad associations.

The programs are assuming shape. Judging from the titles and the authors, this year's programs promise to sparkle with the best ever. Some papers are already in for preprinting. Most of them have been promised for December 15 assuring early distribution for the purpose of obtaining discussions.

The local committees are rounding out their plans and report that they are ready for large numbers at their several social functions.

Then What

Those who have worked long hours to put over this big Ceramic Week event have done their work thoroughly. If each member of this SOCIETY will do his part this 1929 Meeting will be a great impulse to ceramic-ware achievements, far beyond any bounds yet conceived.

If your firm has not taken space at the Exposition, why not? It should, if it is to do its share in making known the high standard which American wares have attained.

Members who have the material for a paper and have not reported that it will be in manuscript by December 15 are short in their bargain with their fellow members.

ANNUAL MEETING

Local Committees for 1929

EXECUTIVE

H. H. Rosenberg, Industrial Publications, Inc.	To work with other committees.
D. F. Albery, Northwestern Terra Cotta Co.	
F. E. Hodek, General Porc. & Enameling Co.	Choose hotel
A. Vodicka, Aetna Porcelain Enameling Co.	Effect agreements
W. W. Wilkins, Lewis Institute	Fix a budget for all expenses.
F. L. Steinhoff, Industrial Publications, Inc.	
	Hotel accommodations.
	Plan with other Associations.

FINANCE

Executive	
W. D. Gates, American Terra Cotta Co.	Raise funds among manufacturers of Middle West, (Ill. Ind. Wis.) for covering Convention Expenses. Banquet, Ladies Entertainment, Smokerette, Trips, Programs, etc.
Wm. Schlake, Illinois Brick Co.	
W. Hogenson, Chicago Vitreous En. Prod. Co.	
G. Fackt, Northwestern Terra Cotta Co.	
I. Fry, Coonley Mfg. Co.	

EXHIBITS OR EXPOSITION

Executive Committee	
F. A. Guignon, *Ceramic Industry*	Solicit exhibitors of ceramic products.
R. A. Beverly, Carborundum Co.	
G. G. Hansen, Golding Sons Co.	Solicit exhibitors of raw materials and equipment.
Thomas Davies, Coonley Mfg. Co.	
E. H. Haeger, Dundee Potteries	
Geo. Blumenthal, Jr., *Ceramic Industry*	
G. Hansen, *Ceramic Industry*	

ENTERTAINMENT

Executive

R. M. Onan, Chicago Vit. Enamel Prod. Co.
J. A. DeCelle, Chicago Hardware Found. Co.
J. A. Dedouch, J. A. Dedouch, Inc.
H. D. Callahan, Northwestern Terra Cotta Co.
H. V. Kaeppel, *Brick and Clay Record*

} Arrange Ladies Committee.
Banquet
Smokerette
Bridge parties
Ladies entertainment, theater tickets, etc.

PLANT TRIPS

Executive

Walter Hull, Midland Terra Cotta Co.
R. A. McDougal, Coonley Mfg. Co.
L. E. Shaw, Western Electric Co.

} Arrange trips to Western Electric Co., stockyards, steel mills, cement plants, ceramic plants, etc.

SERVICE

Executive

H. T. Bellamy, Refractory Products Co.
B. S. Radcliffe, Northwestern Terra Cotta Co.
M. E. Manson, Chicago Hardware Foundry Co.
Leo Thurliman, Midland Terra Cotta Co.

} Arrange for individual rooms for Division Meetings.
Lanterns, program status, Registration, etc.

PUBLICITY

Geo. Blumenthal, Jr., *Ceramic Industry*

} Trade journal notices, newspapers, rosters, etc.

TRANSPORTATION

Ryan Northwestern Terra Cotta Co.

} Get fare and 1/4 rate for delegates Meeting

BRITISH CERAMISTS WILL BE GUESTS OF AMERICAN CERAMIC SOCIETY

One hundred strong they are coming next spring. This SOCIETY is arranging their tour and keeping within bounds the number of plants to be visited. If the invitations received are fair indicators, our British ceramists could spend many a three-week period in this country with a whole-hearted welcome.

The following is the itinerary arranged by a committee of which Professor George H. Brown is chairman.

The party will be in three groups, (1) white wares, (2) refractories, and (3) building materials.

Itinerary for British Ceramic Tour in America

Monday, April 29

(1) Party to be welcomed by a reception committee on board ship. This committee to proceed down the Bay on ship "Macon" (owned by City of New York) or other craft.
(2) Proceed by auto to hotel. After luncheon, motor about city. Optional trips to Metropolitan Museum, N. Y. Architectural Terra Cotta Co., Refractory plant, and Hudson River Brick Plant.
(3) Banquet.

Tuesday, April 30

8:30 A.M. Leave by bus, via Holland Tunnel, for Perth Amboy, arriving at 10:00 A.M.
Optional trips.
(*a*) Federal Terra Cotta Co.
(*b*) Carborundum Co. (refractories).
(*c*) General Ceramics Co. (refractories).
(*d*) Ford and General Ceramic Porcelain.
(*e*) Rossman Tile and others.
Banquet: Parker House.

Wednesday, May 1
8:30 A.M. Leave for Metuchen by auto bus. General Ceramics Co., Sanitary Plant.
11:00 Leave for Trenton by auto bus.
1:00 P.M. Lunch, Stacy-Trent.
2:00 Lenox, Inc.
3:00 Mitchell-Bissell Co.
Banquet

Thursday, May 2
9:00 A.M. Trenton Potteries, Thos. Maddock Sons Co., Scammel China Co., Robertson Art Tile Co. Optional trip to Princeton.
6:00 P.M. Informal dinner; entrain for Philadelphia.

Friday, May 3
8:30 A.M. Tour city, including art gallery, Conkling-Armstrong, Art potteries, Abrasive and Precision, Lavino Refractories.
7:30 P.M. Banquet.
Leave for Washington on Pullman.

Saturday, May 4
9:00 A.M. Bureau of Standards and Geophysical Laboratories.
1:00 P.M. Reception at White House and tour of city.
7:30 Banquet.

Sunday, May 5
Sight-seeing to Mt. Vernon, etc.
Refractories group by B. & O. 6:30 for St. Louis, arriving 4:30 P.M. Monday.
White Ware and Building Materials group motor bus to Baltimore via Annapolis.

Monday, May 6
(Morning) Baltimore brick, potteries, glass, and enamels plants.
(Afternoon) Building Materials motor bus to Lancaster and take train in evening for Pittsburgh.
(Evening) White Wares entrain for Pittsburgh.
Refractories banquet St. Louis.

Tuesday, May 7
(1) Refractories visit plants of Laclede-Christy and of Evens & Howard. Leave for Mexico, Mo. in evening.
(2) White Wares and Building Materials at Mellon Institute, etc.
(3) Lunch at University Club.
(4) Westinghouse.
(5) 5:00 P.M. Motor bus to Beaver Falls.

Wednesday, May 8
(1) White Wares to Mayer China, Rossman Tile, Sherwood, Standard Sanitary, McDanel Porcelain, Universal Sanitary, etc.
(2) Building Materials to Beaver, Smith, Armstrong Cork, Kittanning.
(3) Banquet at Beaver Falls.
(4) Refractories visit plants of A. P. Green at Mexico, Mo. and Walsh Fire Brick at Vandalia, leaving for Pittsburgh in evening.

Thursday, May 9
(1) Refractories at Mellon Institute and Harbison-Walker at Hays Station.
(2) Banquet.
(3) White Wares by bus to East Liverpool.
(4) Building Materials leave Beaver Falls by bus for Alliance, visiting plants enroute.

Friday, May 10
(1) Refractories in Pittsburgh, Kier Fire Brick at Salina, leave for Huntingdon, Pa.
(2) White Wares leave East Liverpool by bus enroute to Canton via Lisbon, Sebring, and Alliance.
(3) Building Materials in Alliance, leaving by bus for Canton, Malvern, Zoar, overnight in New Philadelphia.

Saturday, May 11
(1) Refractories, silica brick plants at Huntingdon; leave by auto for Clearfield; Banquet.
(2) White Wares motor from Canton to Zanesville via New Philadelphia and Cambridge, arriving Zanesville in evening.
(3) Building Materials motor to Zanesville visiting plants in Midvale, Port Washington, New Comerstown.
(4) Banquet in Zanesville.

Sunday, May 12
(1) Refractories motor through mountains about Clearfield.
(2) White Wares and Building Materials motor from Zanesville to Crooksville and Roseville, seeing the Roseville plant of O. S. U. Engineering Experiment Station.
(3) Building Materials motor to Columbus in evening.
(4) White Wares stay in Zanesville.

Monday, May 13
(1) Refractories see plants around Clearfield, Curwensville, etc.
(2) White Wares in Zanesville.
(3) Building Materials by motor to plants in Columbus, New Straitsville, Shawnee, Nelsonville, Logan, etc.

Tuesday, May 14
(1) Refractories in Clearfield and Curwensville district, leaving for Buffalo in evening.
(2) White Wares complete Zanesville tours and motor bus to Columbus.
(3) Building Materials completing plant tours in Ohio.
(4) Banquet.
(5) White Wares and Building Materials entrain for Buffalo.

Wednesday, May 15
(1) Entire party motor to Niagara Falls, Carborundum Co., lunch at Cataract Hotel.
(2) Banquet in evening with the Canadian Clay Products Assn.

Thursday, May 16
(1) White Wares, Buffalo Pottery in forenoon.
(2) Leave for Syracuse at 1:00 P.M.
(3) Refractories guests of Exolon Co., Electric Refractories, and Buffalo Pottery Co., leaving for New York City in evening.
(4) Building Materials see electric kiln at Buffalo Pottery and brick plants nearby leaving for New York City in evening.

Friday, May 17
(1) White Wares in Syracuse.
(2) Refractories and Building Materials in New York City.

Saturday, May 18
(1) Entire party in New York City sailing at noon.

NEW MEMBERS RECEIVED FROM OCTOBER 1 TO NOVEMBER 1

Corporation

Alton Barium Products Co., Alton, Ill. Manufacturers of barium salts. M. E. Turner, representative.

Frontenac Floor and Wall Tile Co., Ltd., P. O. Box, 178, Kingston, Ontario. Everett Townsend, representative.

Smoot-Holman Co., 321 N. Eucalyptus Ave., Inglewood, Calif. Carl H. Seldt, representative.

Streator Brick Co., Streator, Ill. Face and building brick. E. F. Plumb, representative.

Personal

Fletcher Chapman Benton, 173 W. South St., Jackson, Ohio. Managing Secretary, Chapman Coal and Clay Co.

Henry S. Brown, 7 Coarse Bar Drive, Meikleriggs, Paisley, Scotland. Director, Robert Brown and Son, Ltd.

Charles L. Frederick, Jr., 520 Union St., Portsmouth, Ohio. Portsmouth Refractories Co.

Chester C. Hassinger, Plymouth Meeting, Pa. Superintendent, E. J. Lavino & Co.

Paul Laughton, Footscray, Melbourne, Australia. Director, Laughton's Pottery, Ltd.

Sidney Webster McCann, Rochester, N. Y. Ceramic Engineer (enamel research) Pfaudler Co., Rochester, N. Y.

Robert Myers McKinney, Curtis Bay, Baltimore, Md. Chief Chemist, Commercial Pigments Co.

Jos. W. Parker, Jr., 1427 Santa Fe, Los Angeles, Calif. Chief Chemist, California Testnig Laboratories, Inc.

Rawson E. Stark, 90 Pilgrim Rd., Roslyn Farms, Carnegie, Pa. Ceramic Engineer, Crown Chemical Co., Pittsburgh, Pa.

STUDENT

Kenith Dean Atkins, Univ. of Illinois, Urbana, Ill.
Warren F. Copp, Ohio State Univ., Columbus, Ohio.
Kenneth F. Greene, Rutgers Univ., New Brunswick, N. J.
R. G. Hardy, Univ. of Illinois, Urbana, Ill.
Tom Edge Hughes, Univ. of Illinois, Urbana, Ill.
George A. Page, Univ. of Mo., School of Mines and Metallurgy, Rolla, Mo.
Carl H. Rapp, Univ. of Illinois, Urbana, Ill.
Myril Clement Shaw, Penn State College, State College, Pa.
S. J. Slaven, Ohio State Univ., Columbus, Ohio.
E. H. Spencer, N. Y. School of Clayworking and Ceramics, Alfred, N. Y.
John E. Spiker, Univ. of Illinois, Urbana, Ill.
Paul E. Thornton, Iowa State College, Ames, Iowa.

Membership Workers' Record

	CORPORATION		STUDENT
D. P. Ogden	1	A. I. Andrews	1
Office	3	George F. Brown	1
	—	Paul E. Cox	1
Total	4	C. M. Dodd	1
	PERSONAL	R. K. Hursh	1
W. N. Harrison	1	Otto T. Kauffmann	1
G. S. Housman	1	T. N. McVay	2
R. D. Landrum	1	J. B. Shaw	1
A. Malinovszky	1	Arthur S. Watts	2
R. T. Stull	1	F. Westendick	1
A. S. Watts	1		—
Office	3	Total	12
	—		
Total	9	Grand Total	25

QUALIFICATIONS OF PRESIDENTIAL CANDIDATES

Carl B. Harrop, for President

E. M., Ohio State University, 1902; Assistant Chemist, Bronson Portland Cement Co., Bronson, Mich., 1902; Assistant Chemist, National Portland Cement Co., Durham, Ontario, 1903; Chief Draftsman with W. D. Richardson, Brickworks Engineer, Columbus, 1904; Secretary, The Richardson-Lovejoy Engineering Company, Columbus, 1905–1910; Estimator, The Kilbourne & Jacobs Mfg. Co., Columbus, 1907–1910; Secretary, Treasurer, and Manager, The Ceramic Supply and Construction Co., Columbus, 1910–1913; Vice-President, The Richardson-Lovejoy Engineering Co., 1913–1916; Temporary Appointee as Assistant Ceramic Engineer, U. S. Bureau of Standards, Pittsburgh, 1916–1919; engaged in private engineering practice under firm name of Carl B. Harrop, Engineers and Constructors, 1919 to 1927. Part-time Instructor in Ceramic Engineering, Ohio State University, 1910–1913; Assistant Professor in Ceramic Engineering, Ohio State University, 1913–1924. Treas. Ohio Ceramic Industries Assn. 1927 to present time. Present Position, President, Harrop Ceramic Service Co. Engineers & Constructors, Columbus, O.

Publications by Mr. Harrop

"The Design of a Tile Plant with a View to Economical Construction and Operation," *Clay Worker*, pp. 604–607, April, 1913.

"Kiln Expansion and Bracing," 28th Ann. Rept., Nat. Brick Mfrs. Assn., 1915, pp. 59–80.

"The Inadequacy of Static Pressure Draft Gages," *Trans. Amer. Ceram. Soc.*, **18** (1916).

"Methods of Calcining Clay for Grog," *Trans. Amer. Ceram. Soc.*, **18** (1916).

"Heat Balance of a Continuous Tunnel Kiln," *Trans. Amer. Ceram. Soc.*, **19**. 216–35 (1917).

"Increased Efficiency through Proper Furnace Construction," *Brick Clay Rec.*, pp. 583–87, March 26, 1918.

"The Principles and Design of Ceramic Burners," *Brick Clay Rec.*, pp. 765–71, April 23, 1918.

"Test of a Producer Gas-Fired Periodic Kiln," *Jour. Amer. Ceram. Soc.*, **1**, 35–63 (1918).

"The Continuous Tunnel Kiln," *Jour. Amer. Ceram Soc.*, **3**, 697–700 (1920).

"Continuous Tunnel Kilns at the Plant of the Mount Clemens Pottery Company, Mount Clemens, Michigan," *Jour. Amer. Ceram. Soc.*, **4** (1921).

"Conservation of Fuel," 39th Ann. Rept. Nat. Brick. Mfrs. Assn., pp. 101–113 (1925).

"Tunnel Kilns for Heavy Clay Wares," Report, 24th Ann. Conv. Can. Natl. Clay Prods. Assn. 1926.

Patents: Method and Apparatus for Firing Clay Wares, U. S. Pat. 1,338,771. May 4, 1920; Tunnel Kiln, U. S. Pat. 1,442,065, Jan. 16, 1923. Method and Apparatus for Treating Clay Ware in Tunnel Kilns, U. S. Pat. 1,531,181. Mar. 24, 1925.

Frederic A. Harvey, for Vice-President

Grinnell College, Grinnell, Ia., degree B.S. 1904, Univ. of California, degree M.S. 1906, Ph.D. 1909. Physics, Mathematics, Electric Engineering. University Goettingen, 1909. Member Acacia Fraternity. Assistant in Physics, Grinnell College, 1903–1904. Asst. in Physics, 1904–1908, University of California. Whiting Fellow, 1908–1909. Instructor in Physics, Grinnell College, 1909–10. Instructor, Assistant Prof., Associate Prof., Physics, Syracuse Univ., 1910–16. Consulting Physicist, Solvay Process Co., 1912–17. Ceramic Engineer, Semet Solvay Co., 1917–20; United States Refractories Corp., 1921–26; Harbison-Walker Refractories Co., 1926—. Invented electro-chemical recording apparatus, caustic soda and ammonia solutions. Author various articles on atmospheric radio activity, *Journal American Physical Soc.*, amd on refractories, *Journal American Ceramic Society.* Member AMERICAN CERAMIC SOCIETY, A.S.T.M., American Electro Chemical Society, American Refractories Institute. Phi Beta Kappa, Sigma Xi. Secretary, Refractories Division, AMERICAN CERAMIC SOCIETY, 1921–23. Chairman, Refractories Division, AMERICAN CERAMIC SOCIETY, 1924. Trustee, AMERICAN CERAMIC SOCIETY, 1928. Sec. A.S.T.M. Committee C8 on Refractories several years; Vice-Chairman, 1926, Sec. Syracuse Section, American Chemical Society, 1918. Member American Refractories Institute Research Advisory Comm., 1924. Member A.S.M.E. Refractories Comm. Boiler Refractories, 1926–28. Member Joint Comm. on Refractories; American Foundry Men's Assn. Pennsylvania Consistory, Tigris Temple, Pittsburgh Pa.

Publications by Dr. Harvey

"Pyrometer Protection Tubes" (with E. N. McGee), *Bull.*, No. 153, A.I.M. & M.E., 1919.

"Testing Coke Oven Refractories" (with E. N. McGee), *Jour. Amer. Ceram. Soc.*

"Factors Affecting Resistance of Silica Refractories to Abrasion" (with E. N. McGee), *Jour. Amer. Ceram. Soc.*

"Note on Secondary Expansion of Flint Clay," *Jour. Amer. Ceram. Soc.*

"Interesting Facts about Refractories" (a series of articles discussing manufacture and properties), *Fuels and Furnaces.*

George A. Bole, for President

Graduated Geneva Coll., 1906; worked and took graduate work at Columbia Univ., 1906–1910; 2 years teaching in Porto Rico, Porto Rico High School and Univ. of Porto Rico, 1908–1910; M. S. Physical Chemistry, Columbia Univ., 1912; President Barnard Traveling Fellowship, 1912; Prof. of Chemistry, Alfred, Univ., 1912–14; Prof. of Ceramic Chemistry, N. Y. School of Clayworking and Ceramics, 1914–20; Superintendent, Ceramic Station, U. S. Bur. of Mines, Columbus, Ohio, 1922–24; Supervising Ceramist, U. S. Bur. of Mines, 1924–26; Research Professor, Ceramic Engineering, Ohio State Univ., Eng. Expt. Station, 1926—; Secy., Ohio Ceramic Industries Assoc. 1926—; Member: AMERICAN CERAMIC SOCIETY, (Secretary, Heavy Clay Products Div.); A.I.M.M.E. (Chairman, Refractories Div. of Nonmetallic Section); A.S.T.M. (Chairman, Comm. on Refractories) S.P.E.E., A.R.I. On committees of A.S.M.E., (Boiler Refractories); A.F.A. (Comm. on Foundry Refractories); National Research Council (Moulding Sands). Sigma Xi and Phi Lambda Upsilon.

Publications by Mr. Bole

"Drop Weight of Aqueous Solutions and the Surface Tension Calculated from Them" (with J. L. R. Morgan), *Jour. Amer. Chem. Soc.*

"Rôle of Chlorides in the Volatilization of Iron from Enamels" (with R. M. Howe), *Trans. Amer. Ceram. Soc.*

"An Air Expansion Porosimeter for Brick" (with F. G. Jackson), *Jour. Amer. Ceram. Soc.*

"Oxidation of Ceramic Ware during Firing" (with F. G. Jackson), *Jour. Amer. Ceram. Soc.*

"An Apparatus for Studying Dissociation Temperatures of Carbonate Rocks," *Jour. Amer. Ceram. Soc.*

"Mechanism of Plasticity from the Colloid Standpoint," *Jour. Amer. Ceram. Soc.*

"Heat Required to Fire Ceramic Bodies" (with MacGee, Simpson, and Watts), Ohio Eng. Expt. Sta., *Bull.*, No. 38.

"Problems in Firing of Refractories" (with Blizzard, Rice, Ogden, and Sherman), U. S. Bur. Mines, *Bull.*, No. 277.

"Beneficiation and Utilization of Ga. Clays" (with R. T. Stull), U. S. Bur. Mines, *Bulletin*, No. 252.

"Burning Problems of Industrial Kilns" (with R. T. Stull and R. H. Watkins), coöperative publication.

"Some Notes on Fuel Ratios in the Firing of Refractories," American Refractories Institute, *Circular*.

"Some Refractories Which Are in the Development Stage," Technical Paper, American Refractories Institute, *Tech. Paper*, No. 5.

"Refractory Possibilities of Some Georgia Clays" (with R. T. Stull), *Jour. Amer. Ceram. Soc.*

"Notes on Cyanite and Diaspore Refractories" (with E. J. Vachuska), *Jour. Amer. Ceram. Soc.*

"Utilization of Dolomite for Refractories," U. S. Bur. Mines, *Rept. of Investigation*, No. 2627.

"Graphite Crucible Investigation, Steel Melting" (with R. T. Stull), U. S. Bur. Mines, *Rept. of Investigation*, No. 2512.

"The Application of Refractories in Boiler Furnaces" (with Brooks, Helser, and Sherman), *Power*, Aug. 20 and 25, 1928.

"Observation on the Requirements of Refractories for the Open Hearth," (with F. H. Davis), *Trans. A.I.M.M.E.*

"Use of Sedimentary Kaolins of Georgia in Whiteware" (with R. T. Stull), *Jour. Amer. Ceram. Soc.*

"Washing Tests on Georgia Clays" (with R. T. Stull), *Jour. Amer. Ceram. Soc.*

"Utilization of Ga. Clays in Manufacture of Face Brick" (with R. T. Stull), *Jour. Amer. Ceram. Soc.*

"Making of Dolomite Brick and Study of their Properties" (with A. I. Andrews and J. R. Withrow), *Jour. Amer. Ceram. Soc.*

"Experiments in Commercial Manufacturing of Dolomite Brick" (with M. E. Holmes) A.R.I. (in print).

"Caustic Calcination of Dolomite and its Use in Sorrel Cements" (with J. B. Shaw), *Jour. Amer. Ceram. Soc.*

"Developments in Oxychloride Stucco and Flooring" (with J. B. Shaw), *Jour. Amer. Ceram. Soc.*

"Dead Burning of Dolomite" (with Robson, Andrews, Withrow and Stull), *Bulletin* No. 28, Ohio State Eng. Expt. Sta., *Bull.*, No. 28.

"Clay Mining and Manufacturing in Ohio" (with H. E. Nold), Circular No. 14, Ohio State Eng. Expt. Sta., *Circ.*, No. 14.

"Drain Tile Manufacturing in Ohio," *The Clay Worker*.

Harry G. Schurecht, for Vice-President

Ceramic Chemist, Findlay Clay Pot Co., Washington, Pa., 1914–1916; associate Ceramic Chemist, Bureau of Standards, Pittsburgh, Pa., 1916–1917; Ceramic Chemist, Bureau of Mines, Lord Hall, Ohio State Univ., Columbus, Ohio, 1917–1923; Senior Fellow, Vitrified Salt Glazed Sewer Pipe Fellowship, Mellon Institute, Pittsburgh, Pa.; Senior Research Associate, National Terra Cotta Society Fellowship, National Bureau of Standards, Washington, D. C., 1925. Served as abstractor for *Journal of the American Ceramic Society*, 1919–1927.

Publications by Mr. Schurecht

"A Type of Crystalline Glaze at Cone 3" (with Rand), *Trans. Amer. Ceram. Soc.*, **16**, 342 (1914).

"The Firing Properties of Some American Refractory Clays," *Trans. Amer. Ceram. Soc.*, **19**, 246 (1927).

"The Relation of Salt to Clay in the Purification of Clays," *Trans. Amer. Ceram. Soc.*, **19**, 460 (1927).

"The Use of Sulphuric Acid in the Sediment of Kaolins," *Trans. Amer. Ceram. Soc.*, **19**, 130 (1927).

"Effects of Electrolytes on Properties of Clays," *Jour. Amer. Ceram. Soc.*, **1**, 201 (1918).

"Properties of Some Ohio and Pennsylvania Stoneware Clays," *Jour. Amer. Ceram. Soc.*, **1**, 201 (1918).

"Pycnometer Operated as a Volumeter," *Jour. Amer. Ceram Soc.*, **1**, 556 (1918).

"The Effect of Electrolytes on the Properties of Graphite Crucible Bodies," *Jour. Amer. Ceram. Soc.*, **2**, 443 (1919).

"Effect of Variable Pressure and Tar Content on the Briquetting of Alabama Graphite," *Jour. Amer. Ceram. Soc.*, **2**, 391 (1919).

"Experiments in Dead-Burning Dolomite," *Jour. Amer. Ceram. Soc.*, **2**, 291 (1919).

"A Machine for Testing the Hot Crushing Strength of Fire Brick," *Jour. Amer. Ceram. Soc.*, **2**, 602 (1919).

"Behavior of Fire Bricks in Malleable Furnace Bungs" (with Douda), *Jour. Amer. Ceram. Soc.*, **3**, 556 (1920).

"Direct Reading Overflow Volumeter," *Jour. Amer. Ceram. Soc.*, **3**, 730 (1920).

"Elutriation Tests on American Kaolins," *Jour. Amer. Ceram. Soc.*, **3**, 355 (1920).

"Experiments in Aventurine Glazes," *Jour. Amer. Ceram. Soc.*, **3**, 971 (1920).

"Note on the Effect of Firing Temperatures on the Strength of Fireclay and Stoneware Bodies," *Jour. Amer. Ceram. Soc.*, **4**, 366 (1921).

"Experiments in Dead-Burning Dolomite and Magnesite," *Jour. Amer. Ceram. Soc.*, **4**, 127 (1921).

"Sedimentation as a Means of Classifying Extremely Fine Clay Particles," *Jour. Amer. Ceram. Soc.*, **4**, 812 (1921).

"Separation of Lime from Dolomite," *Jour. Amer. Ceram. Soc.*, **4**, 558 (1921).

"The Microscopic Examination of the Mineral Constituents of Some American Clay," *Jour. Amer. Ceram. Soc.*, **5**, 3 (1922).

"The Mechanical Movement of Water through Certain Clays and Its Control," *Jour. Amer. Ceram. Soc.*, **5**, 928 (1922).

"The Properties of Some Claylike Minerals of the Bentonite Type," *Jour. Amer. Ceram. Soc.*, **6**, 940 (1923).

"The Behavior of Fire Brick in Malleable Furnace Bungs," *Jour. Amer. Ceram. Soc.*, **6**, 1232 (1923).

"Clay Sewer Pipe Manufacture. I. Magnetic Separation of Iron-Bearing Minerals from Clays," *Jour. Amer. Ceram. Soc.*, **6**, 615 (1923); "II. The Effects of Variable Alumina, Silica, and Iron Oxides Contents in Clays on Some Properties of Salt Glazes," *ibid.*, **6**, 717 (1923); "III. The Influence of Different Salt-Glazing Temperatures upon the Color and Gloss of Salt Glazes Obtained with Variable Silica, Alumina, and Iron Oxide Contents," *ibid.*, **7**, 411–22 (1924); "IV. Heat Distribution in Sewer Pipe Kiln," *ibid.*, **6**, 717 (1923); "V. The Influence of Varying Lime Contents in Clays upon Some Properties of Salt Glazes Produced at Different Temperatures," *ibid.*, **7**, 539–47 (1924).

"An Automatic Direct Reading Laboratory Scale for Weighing Briquettes," *Jour. Amer. Ceram. Soc.*, **6**, 491 (1923).

"Technical Developments in Dolomite Refractories," *Jour. Amer. Ceram. Soc.*, **6**, 278 (1923).

"Note on the Relation of the Structure of Clay Grains to the Plasticity of Clay," *Bull. Amer. Ceram. Soc.*, **1**, 153 (1923).

"Behavior of Fire Brick in Malleable Iron Furnace Bungs," *Trans. Amer. Foundryman's Assn.*, **30**, 381 (1923).

"Properties of Some European Plastic Fire Clays," (with Bleininger), Bur. of Stand., *Tech. Paper*, No. 79 (1916).

"The Fire Clays of Maryland," (with Watts, Swartz, and Hall), Maryland Geol. Survey, Special Publication, Vol. 91, 23 (1922).

"The Properties of Some Stoneware Clays," Bur. of Mines, *Tech. Paper*, No. 233 (1920).

"The Use of Electrolytes in the Purification and Preparation of Clays," Bur. of Mines, *Tech. Paper*, No. 281 (1922).

Scum Prevention, U. S. Pat., 1,583,903 (1926).

Salt Glazing, U. S. Pat., 1,583,901 (1926).

Salt Glazing, U. S. Pat. 1,583,902 (1926).

"Methods for Testing Crazing Caused by Increases in Size of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **11**, 271 (1928).

LOCAL SECTION MEETINGS

Pittsburgh Section to Meet on December 11

The December meeting of the Pittsburgh Section will be held on December 11 in New Castle, Pa. Those who attend will assemble at the Castleton Hotel for luncheon at 12:30. In the afternoon inspection trips will be made to the Universal Sanitary Mfg. Co., the New Castle Refractories Co., and the Shenango Potteries.

Dinner will be served to those attending at the Castleton Hotel after which George A. Bole, Secretary of the Ohio Ceramic Industries Association will describe the work in progress at the Roseville Experimental Clay Products Plant. Those who wish to participate should make reservations with W. Keith McAfee, Universal Sanitary Mfg. Co., New Castle, Pa.

Pittsburgh Section November Meeting

The members of the Pittsburgh Section held a meeting at Mellon Institute, on November 13. The address of the evening was given by J. Spotts McDowell of the Harbison-Walker Refractories Co., on the subject, "Technical Advances in the Manufacture of Refractories."

Among those present were: Louis A. Smith, H. A. Deuel, Wm. Haberthin, J. E. MacDonald, K. Backhind, L. R. Astie, J. C. Murray, Chas. Jelley, and C. P. Spangler, of the Jones and Laughlin Steel Co.

G. E. Mercer and F. G. Hess, Carnegie Steel Co.

Erwin Sohn, Drury Turner, R. C. Boyd, and R. J. Paddock, Standard Sanitary Mfg. Co.

R. Richardson, Babcock and Wilcox Co.

W. Keith McAfee, Richard E. Rief, and C. J. Kirk, Universal Sanitary Mfg. Co.

S. M. Kier and B. E. Whitesell, Kier Fire Brick Co.

Joseph A. Martz, McLain Fire Brick Co.

J. Spotts McDowell and E. M. Sarraf, Harbison-Walker Refractories Co.

P. A. Robison and K. I. Robinson, Garfield Fire Clay Co.

Charles A. Fettke, Carnegie Tech.

P. A. Smith, A. F. Smith Co.

R. E. Stark, Crown Chemical Co.

S. M. Phelps, R. F. Ferguson, S. S. Cole, E. W. Tillotson, E. J. Casselman, C. H. Geister, A. C. Hughes, W. R. Kerr, E. B. Read, B. A. Rice, G. R. Daniel, G. K. Lowe, S. M. Swain of Mellon Institute.

Baltimore-Washington Section

The initial meeting of the 1928–29 season of the Baltimore-Washington Section of the AMERICAN CERAMIC SOCIETY, was held in Baltimore, Md., at the Emerson Hotel, Nov. 24, 1928. The members of the Section were the guests of the Carr-Lowrey Glass Co. at dinner, after which the following program was given:

(1) A talk on "The Application of Pyrometer and Temperature Control Equipment in the Ceramic Industries," by J. H. Ferguson, Bristol Company.

(2) "Cast Iron for Enameling," by H. G. Wolfram, Porcelain Enamel & Mfg. Co.

(3) Election of officers was held, the names to be announced later.

(4) A discussion took place relative to the proposed visit of the British ceramic manufacturers visit in the spring of 1929.

St. Louis Section Meets at Rolla, Mo.

On Saturday, November 3, the members of the St. Louis Section, AMERICAN CERAMIC SOCIETY, Missouri Refractories Association, Enameler's Club of St. Louis, and Rolla

Student Section of the SOCIETY held a joint meeting at the School of Mines and Metallurgy, Univ. of Missouri, Rolla, Mo.

Ross C. Purdy, General Secretary of the AMERICAN CERAMIC SOCIETY gave a talk on "Organized State Industrial Support of Ceramic Research," Amos P. Potts of Brazil, Ind., showed pictures and talked on the European Tour and Plant Visits made by the AMERICAN CERAMIC SOCIETY last summer. Miss Marie Regnier, Secretary of the Enameler's Club of St. Louis gave a talk on "Recent Developments in the Use of Enamels," and displayed an exhibit.

Other talks were made by C. H. Fulton, President, School of Mines and Metallurgy, H. A. Buehler, State Geologist, M. E. Holmes, Professor of Ceramic Engineering, Fred Dickey, of Kansas City, Mo., R. M. Sievers, of the Missouri Refractories Association, and James Spaulding, of the Senior Dept. of Ceramic Engineering, at Rolla.

FIG. 1.—Meeting at Rolla, Mo., of St. Louis Section AMERICAN CERAMIC SOCIETY, St. Louis Enamelers' Club, Missouri Refractories Association.

A complimentary luncheon was served through the courtesy of the Missouri Bureau of Mines and Geology, and the Missouri School of Mines and Metallurgy. Homecoming Day at the School of Mines was observed and the members attended the football game. Later in the afternoon they visited a diaspore pit in the vicinity of Rolla.

C. H. Modes was chairman of the Arrangements Committee.

Among those who attended this meeting were:

From St. Louis

Robert Lee Blessing, Laclede-Christy Clay Products Co. Others from this company were L. H. Blue, Russell E. Fricke, F. R. Meyer, Guy Sanders, James G. Thompson, and Henry Warnecke, Jr.

Foster Holmes, Perry C. McCollom, Frank Prevatil, E. B. Stone, and B. W. Willson, of the Evens and Howard Fire Brick Co.

Walter H. Hoagland, Laclede Gas Light Co., and with him were: Lee M. Hallerman, Marwin Schmidt, Clarence Hoagland and Ellsworth Staver.

Russel Britt and Jos. Hehr, and F. G. Jaeger, Superior Enamel Products Co.

Frederick E. Bausch.

Louis L. Kamernoyer, Federal Brilliant Co.

E. O. McFadon, Ferro Enamel Supply Co.

E. F. Mitchell, Southern Manganese Co.

Miss Marie Regnier, Porcelain Tile Co.

Karl Otto Roehling, St. Louis and Saechsische Emaillier & Hanswerke, Lautor-Saxony, Germany.

C. E. Rontron and E. P. Stretch, Koken Companies.

F. J. Stretch, E. Kerry Co.
J. Stocke, Jr., Progress Brick Co.
August Vollmer, Jr., St. Louis Pottery Mfg. Co.
R. W. Erwin, Tonell, Benson, and L. A. Kimberling.

From Rolla, Mo.

Those from the School of Mines and Metallurgy were, Charles H. Fulton, Director; M. E. Holmes, Professor of Ceramic Engineering; C. M. Dodd and A. J. Paul, Department of Ceramic Engineering; C. R. Forbes, Professor of Mining; H. S. McQueen, Missouri Geol. Survey; George R. Dean, Professor of Mathematics; and H. A. Buehler, State Geologist.

Students in attendance were E. H. Frauenfelder, S. L. Harrod, Harlow G. Jones, Wm. McCracken, Ed Meeka, G. A. Page, J. A. Spaulding, S. J. Toapach, Robert E. Lee, and Edwin T. Harvey.

From Other Points in Missouri

Robert H. Miller, Farber Brick Co., and Luther Nickell, Fulton Fire Brick Co., Fulton, Mo.

R. S. Bradley, Chas. A. Freeman, and L. J. Miller, A. P. Green Fire Brick Co., Mexico, Mo.

E. E. Noble, New Florence Firebrick Co., New Florence, Mo.

H. J. Moreland, St. James, Mo.

From Other States

Roy H. Jaeger, J. B. Ford Co., Wyandotte, Mich.
E. C. Hunze, and W. E. H. Knight of the Aluminum Ore Co., E. St. Louis, Ill.
Edw. E. Krause, Chambers Brothers, Philadelphia, Pa.
C. H. Modes and F. S. Modes, Alton, Ill.
Wm. Codwin, Commonwealth Edison Co., Chicago, Ill.
Amos P. Potts, Clay Products Co., Inc., Brazil, Ind.
Ross C. Purdy, Columbus, Ohio.

Ladies in Attendance

Among the ladies who enjoyed the social gathering held in conjunction with this meeting were: Mrs. Geo. R. Dean, Mrs. C. M. Dodd, and Mrs. M. E. Holmes, of Rolla, Mo.; Mrs. Ross C. Purdy, Columbus, Ohio; Mrs. C. H. Modes and Miss Sarah Modes, Alton, Ill.; Miss Mary Lillian Garr, La Grange, Ky.; Mrs. L. H. Nickell, Fulton, Mo.; Mrs. B. W. Willson, Maplewood, Mo.; Mrs. E. C. Noble, New Florence, Mo. The following were from St. Louis: Miss Helen Brown, Miss Nell Burke, Mrs. W. H. Hoagland, Mrs. F. G. Jaeger, Miss E. Kauer, Mrs. L. L. Kamernoyer, Mrs. E. O. McFadon, Mrs. E. F. Mitchell, Miss Marie Murphy, Miss Verna Owen, Mrs. C. E. Rontron, Mrs. Minnie Stretch and children, Jane and John; Mrs. August Vollmer, Jr., and Mrs. W. M. Weigel.

ACTIVITIES OF THE CERAMIC SCHOOLS

Georgia School of Technology

The Ceramic Department of the Georgia School of Technology began its fifth year with 35 students, freshmen not included. Satisfactory growth has been shown both with regard to student enrollment and to ceramic development in the southeast.

J. P. Breen, who was an honor graduate of the Ceramic Department of the University of Illinois, has been added to the teaching staff. Mr. Breen came from the Western Electric Company.

The Student Branch of the AMERICAN CERAMIC SOCIETY has shown a continually increasing activity. An interesting program has been prepared for the coming year including talks by ceramic leaders, trips to local industries having ceramic application, motion pictures, and ceramic discussions by members of the group.

The department has, for the past year, been coöperating with the Georgia Geological Survey in an investigation of the kaolins of the state. The field and laboratory work have been completed and the results will be published in the early spring. This work

has been as comprehensive as possible and it is hoped will prove a beneficial reference for anyone interested in the kaolins of Georgia. Immediately following the publication of the kaolin survey, field work will be started on the location of the shales of the state. Special emphasis will be placed upon their adaptability for ceramic manufacture.

Carl H. Rapp Receives Keramos Award

As a recognition of his diligence and scholastic work as a freshman at the University of Illinois, Carl H. Rapp has received the Keramos award. This is presented at the first open meeting of the Alpha Chapter of Keramos at the University of Illinois to the student whose work in the previous year as a freshman in the Department of Ceramic Engineering has shown the highest rating of the group.

The award consists of a student membership in the AMERICAN CERAMIC SOCIETY for one year.

Each year Keramos sponsors this meeting which is in the form of a professional and social gathering for the Freshmen and new students to acquaint them with the work of the Ceramic Engineering Department at the University and to give them some idea of the field they intend to enter.

School of Mines and Metallurgy, Univ. of Mo.[1]

The Ceramic Department of the Missouri School of Mines, at Rolla, Mo., opened its third year this fall, with an enrollment of thirty. All four years' work are now being given, the laboratories are equipped for instruction in all branches of the ceramic industry, and other facilities such as library, staff, etc., have been rounded out.

The Department graduated its first students last spring: Charles R. Freeman of Steubenville, Ohio, and William K. Schweickhardt of St. Louis, Missouri. Mr. Freeman is now ceramic engineer for the A. P. Green Fire Brick Company, Mexico, Mo., and Mr. Schweickhardt is ceramic engineer for the Johns-Manville Company, located at Chicago, Ill. Four students are scheduled to graduate this year.

The students of the Ceramic Department have organized a local ceramic society which they have chosen to name the "Orton Society" in honor of the founder of ceramic education in this country, General Edward Orton, Jr., of Columbus, Ohio.

New York School of Clayworking and Ceramics[2]

The course in ceramics offered at the summer school was well attended having a total registration of eighteen. The majority of those who took the summer school courses were teachers, sculptors, and potters who desired to learn the rudiments of ceramics.

The Ceramic School opened this fall with a total registration of 167 students, 110 men and 57 women. The proportion of students taking the art course is on the increase as compared with the figures of other years.

The senior engineering class has made two inspection trips to plants in the vicinity. The first trip was to Rochester where the plants of the Lapp Insulator Co. and the Taylor Instrument Co. were visited. The second trip was to Buffalo where the engineers visited the Jewettville Brick Plant, The Buffalo Shale Products Co., manufacturers of bricks, the Bessemer Cement Co., the Buffalo Pottery, and the American Radiator Co., as well as the Carborundum Co., located at Niagara Falls.

The Student Branch of the AMERICAN CERAMIC SOCIETY, the Ceramic Guild, and the honorary ceramic fraternity, Beta Pi Kappa, have resumed meetings and there have been many interesting discussions on matters of ceramic interest.

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[1] M. E. Holmes, Professor of Ceramic Engineering.

[2] John L. Call.

Ohio State University Student Branch

On Tuesday evening, November 13, fifty members of the Student Branch, AMERICAN CERAMIC SOCIETY at Ohio State University, held their annual election of officers at the offices of the AMERICAN CERAMIC SOCIETY, 2525 N. High St., Columbus, Ohio. The new officers for the Student Branch are:

Chairman, H. Z. Schofield
Vice-Chairman, Edwin Seabright
Secy.-Treas., (pro tem) Mr. Pearch
Corresponding Secy., Edmond Czolges
Rep. to Advisory Board, *Ohio State Engineer*, W. F. Copp.

Following this election, Ross C. Purdy, General Secretary of the AMERICAN CERAMIC SOCIETY, gave a short talk on the (1) founding of the SOCIETY, (2) its purpose to draw together men of like interests so that their experiences can be used to their mutual benefit, (3) and the part the SOCIETY is playing by its publications and branch organizations to assist the students as new-comers into the ceramic industry to find their place.

Cider and doughnuts were served by Mr. Purdy and his assistants on the editorial and secretarial staff.

Ceramic Division, Department of Metallurgy, University of Toronto[1]

The fall term opened with three senior and four junior students. The number in the first and second years is uncertain as students do not definitely decide their course until the beginning of the third year.

On October 12, an inspection trip was made to the ceramic plants of Hamilton, Ontario, as arranged by the Canadian National Clay Products Association. This was one of a series of trips sponsored by the Association. Two meetings were held during the summer in order that the students might exchange notes and become better acquainted with plant operation.

An interesting addition to the laboratory equipment is an electric furnace which is being designed through the courtesy of the Fitzgerald Laboratories at Niagara Falls.

Research work is being done on the commercial possibilities of the fire clays to be found in the Moose River Basin. The report on the clay deposits of this region is in press as a Report of the Ontario Department of Mines.

A survey of the ceramic industries of Ontario was started during the past summer. This survey will be continued next summer and a report issued shortly thereafter.

Virginia Polytechnic Institute

On November 1, John W. Whittemore, took charge of the new Ceramic Engineering Department at Virginia Polytechnic Institute. The work will be started by making a survey of the state for ceramic resources, followed by research with the manufacturers. The program will be carried out before the teaching of ceramics is begun.

Prof. Whittemore is continuing the direction of the work in Louisiana until the survey is completed, but there will be no resident teaching of ceramic engineering at Louisiana State University.

OBITUARY

W. H. Fulper

William H. Fulper, head of the Fulper Pottery, the oldest business plant in Flemington, N. J., died suddenly at his home on October 15, from heart disease. He was born

[1] By Robert J. Montgomery, Assistant Professor of Ceramics.

May 15, 1872, a son of the late William H. Fulper. His grandfather, Abram Fulper founded the pottery business in 1805. Mr. Fulper attended Lawrenceville School and Princeton University. He was treasurer of the Flemington Rotary Club and a member of the Metropolitan Museum of Arts, the Boston Society of Arts and Crafts, the Trenton Club, the Trenton Consistory Club, the Princeton Club of New York, and the AMERICAN CERAMIC SOCIETY. He is survived by his widow, the former Ella Pearce, a son, William H. Fulper, Jr., and a daughter, Miss Willette Fulper.

W. H. FULPER

In the passing of W. H. Fulper this SOCIETY has lost one who consistently supported its activities. Those who had the good fortune of being one of "Bill's" friends have lost a real neighbor, a helpful friend.

It required nerve, push and real ability to earn a world-wide reputation such as Mr. Fulper enjoyed.

He lived, loved, worked, and made a lasting record of achievement. He left this world richer because of the life he lived and the work he did.

NOTES AND NEWS

DR. SOSMAN TO HEAD NEW LABORATORY

Robert B. Sosman, formerly physicist and assistant director at the Geophysical Laboratory of the Carnegie Institution in Washington, has resigned to become associated with the new research laboratory of the United States Steel Corporation. The new laboratory, under the direction of John Johnston, formerly of Yale University, is now setting up equipment at the plant of the Federal Shipbuilding and Dry Dock Company, at Kearny, N. J., a few miles west of New York City. Silicate slags and refractories, with which Dr. Sosman has been concerned at the Geophysical Laboratory, will be among the ceramic problems to be studied.

REPORT OF TEHNICAL COMMITTEE III, A.S.T.M. ON PLASTICITY, CONSISTENCY, ETC.

The properties of matter involving flow are very diverse and many of the terms used do not even suggest that flow is involved. Such properties are ductility, hardness, solubility, melting point, and shortness, as well as the more obvious properties of flow, such as consistency, plasticity, and viscosity. It is assumed that only a few fundamental properties of matter are involved in the flow and that these can eventually be expressed in absolute units. It has been suggested that such fundamental properties may be: (1) fluidity, ϕ the reciprocal of viscosity, η, for fluids only; (2) mobility, μ, the reciprocal of some property, ζ, which denotes the stiffness or immobility of the material; (3) yield value, f, and ultimate strength, I; and (4) elasticity, e, the reciprocal of the rigidity, r.

If these properties are the fundamental properties of flow, it would be desirable to relate the properties used in practice to these which appear to be more fundamental and

expressible in absolute units. We may assume that further study may introduce ye other properties of flow, but these have been suggested. The above properties may be defined in a later report.

Consistency and Plasticity It appears that neither consistency nor plasticity can be considered as a fundamental property to which a numerical value can be given, but on the other hand both are complex properties for which the following definitions are submitted for publication as information:

Consistency is that property of a material by which it resists permanent change of shape and is defined by the complete flow-force relation. If in nonturbulent flow the ratio of flow to force is constant, the material is said to be fluid, otherwise it is plastic.

Plasticity is that property of a material by which, as the shearing stress is lowered, the material resists change of shape relatively more than in the case of a fluid; thus for a plastic material the ratio of flow to force is not constant.

There are various types of plastic flow. There are also many factors which affect the flow, such as temperature, concentration, size and shape of particle, and adhesion between particles, but they are not considered as fundamental properties of flow. Three types of deformation are given as illustrative: (1) Elastic Deformation, $s=eFd$; (2) Rate of Fluid Deformation, $v=\phi\ Fd$; (3) Rate of Plastic Deformation $v=\mu(F-f)d$, where

s = distance	e = elasticity
v = velocity	ϕ = fluidity
F = shearing stress	μ = mobility
d = thickness of the deformed material	f = yield shear value

Respectfully submitted on behalf of the subcommittee,

E. C. BINGHAM, Chairman

THE RESEARCH PROGRAM AT THE OHIO STATE ENGINEERING EXPERIMENT STATION[1]

Description of Work at Roseville

It has been repeatedly pointed out that the work at Roseville has to do more particularly with the interpretation of research already available to the industry and to plant applying research to specific plant problems whether they have to do with product or with process. It is not the purpose of the Engineering Experimental Station under any circumstance to permit its researches to fall short of plant proving and it is hoped that they will be plant applied by the industry at large.

The work at Roseville can be divided into two general heads, (*a*) research and (*b*) service. While the major aim at Roseville has to do with plant application of existing data, research of a fundamental nature will not be neglected. There is still much necessary information that is unavailable before many of the problems fundamental to the heavy clay industries can be taken up. These problems are under investigation at this time. The immediate service of the Roseville plant as contrasted with the several other laboratories now working on research problems in the heavy clay field is that it is proposed to try out under plant conditions research data already available.

The service feature of the Roseville plant is unique in this country and is entirely unique in the heavy clay field. Ohio is the first state to recognize that the state owes a service to small industries other than agriculture.

The service idea as it is at present worked at Roseville has developed along two lines (1) The first is service in equipment and personnel. Any manufacturer is free to send a

[1] Presented by G. A. Bole before a meeting of the Ohio Ceramic Industries Association, Nov. 2–3, 1928.

man to Roseville to work on a specific plant problem, provided the work does not interfere with research program in progress. The laboratory and plant facilities are gratis. A helper familiar with the operation of the equipment is also gratis. These helpers are state wards. In most cases they are capable and willing workers. Advice in regard to how to attack any problem brought in is given by the engineer in charge. Twenty-two companies have sent men to Roseville to do work under this plan within the past two months.

It is not always possible for a company to send a man to Roseville on a troublesome plant problem. In order to obviate this necessity it is hoped, in the near future, to have a service engineer who will be available for such work at a charge covering his salary only. The advantage, however, in having the company send its own man to Roseville is that he is familiar with the problem in all its aspects and its solution and will carry the idea of its plant application at home in a way impossible if the data were obtained by one of the Experimental Station engineers.

(2) The second aspect of the service feature of the work at Roseville is that advice based on either theory or experience can be offered which will lead to the solution of a problem on the plant without any work being done at Roseville. Experience thus far indicates that a combination of the two practices is usually necessary.

It is not the intention or purpose of this work to encroach upon the field of the consulting engineer. Any work placed at Roseville should have its basis of research, test, or utilization of available equipment. In one instance a consulting engineer was sent by one of the plants to do work for them in place of one of their own men. Another consulting engineer is to plant apply results obtained at Roseville at a plant outside of the state.

It is hoped that the different industries either operating as groups in the Ohio Ceramic Industries Association or through their national or state trade associations will put engineers at Roseville to work on specific problems or to act as field contract men whose duties it would be to put to work in their respective industries the findings of the experiment plant. The Hollow Building Tile Association has a man at Roseville and one at Columbus working under this plan. Other heavy clay groups will probably find it advantageous to coöperate in a similar way.

Recent Work at Roseville

(1) Work is being carried on having to do with the alteration of the properties of heavy clays. The subject was studied fundamentally for more than a year by a graduate student, Mr. Husain. The results have proved out so well that the most successful process developed during the laboratory investigation is now being plant applied at one plant and the chances are that others will also use the process.

(2) No work has ever been done for the drain tile companies of the state, of which there are over one hundred. Using four senior students under Mr. Everhard, tile from fifteen plants representing the different clays, methods of manufacture, etc., have been tested for (*a*) absorption (*b*) crushing strength and (*c*) freezing, by both the sodium culphate method and water-freezing.

Several companies producing or developing glazed brick in the state asked that autoclave tests and freezing tests be run on their product. The work was expanded into a research covering all glazed products manufactured in the State. Data on ware from the individual plants has already been reported to them and the results of this investigation will be in printed form shortly.

The Refractories Section requested that a research be initiated involving dry-press refractories. The first phase of the work has to do with the securing of dry-press body mixes ready for the press from all the plants manufacturing dry-press brick and trying out the mixes under varying pressures in the hydraulic press. The brick will be fired

at the plants and returned to Roseville to test. The work will yield comparative data on hydraulic and mechanical presses and data in regard to the effect of pressure on the properties of the fired ware. Mr. Birch is the investigator.

The Hollow Tile Association is financing the work which Mr. Hall is doing on the developing of a light weight clay masonry unit. This work has progressed in a very satisfactory manner to date and will be reported to the Hollow Tile Association at their annual meeting. The office of the Association receives monthly reports of progress.

On November 15, Harold Harrison will be employed as research engineer at Roseville. Mr. Harrison has been with the vitrified pipe people as research engineer for several years and is familiar with their problems. Problems incident to salt-glazed ware will be studied if the industries involved show sufficient interest in the work; otherwise Mr. Harrison's time will be spent in another field.

Some of the problems attacked as service problems are as follows:

(1) Two companies manufacturing special refractories have tried their mixes in the hydraulic press at Roseville and fired their product in a H. T. kiln to a temperature higher than could be obtained at their plants.

(2) Autoclave and freezing tests were run on different glazes used on enamal and glazed brick being developed. In each case the work prevented an unproved ware from being placed on the market.

(3) A survey of clay pits for two companies was made to determine where the troublesome incidental minerals were located. Allutriation and fire tests were run. In each case the trouble was located. In one case recommendation was made that the tailings from the screen be discarded while in the other case the troublesome clay was left as the mine floor.

(4) One company that discovered a bad case of kiln marking in certain of its kilns ran a vitrification range test on the various shales and clays used. The tests made will enable the company to eliminate their trouble-after they have studied the firing a little more carefully.

(5) A binder for flint clay, grog, quartz and other non-plastics was tested by a concern interested in its use. The results saved them the embarrassment of investing in worthless (as far as their problem was concerned) patents and undertaking a development destined to fail. A plant with high breakage in its dry-pressed brick kilns brought the problem to Roseville. It was found that there was a very definite temperature above which the brick must not be heated until thoroughly dry. With this information in hand the trouble was overcome by a wise utilization of control instruments.

These are only a few of about thirty problems brought to this Experimental Station by the heavy clay and refractories manufacturers during the past three months.

Research at Ohio State University Campus

In the Engineering Experiment Station on the Campus and in coöperation with the U. S. Bureau of Standards three men are working as fellows in the Ceramic Department. These men are studying:

(1) The cause of crazing in glazed wares which occurs after long service. The mode of attack has to do with a study of the hydration, with accompanying volume change, of fired clay wares. Mr. Holscher is the investigator.

(2) The development of a flux for use in whiteware bodies with the idea in view of developing the body at a lower temperature than is possible under present practice. The fluxes are developed as eutectics. The problem of improving quality by increased translucency, mechanical strength, and glaze fit are to be studied. Mr. Collins is investigating this problem.

(3) A study of heat reactions of the various incidental minerals found in heavy clays and their effect on the ware is being studied by Mr. Machwart.

In addition to these three fellowships which are financed jointly by the U. S. Bureau of Standards and the Engineering Experiment Station, there are fellowships financed by the Aluminum Company of America on the utilization of certain of their products in enamels (R. Melville Pearce, investigator) and a fellowship financed by the Electrical Porcelain Manufacturers Association. This investigation has to do with a study of sagger life in this industry and the possibility of improving the present practice. Mr. Austin is the investigator.

Thus, in addition to the work at Roseville, five graduate students are working at the University on a fellowship basis. These men will receive their degrees in the Ceramic Department of the University. The fellowships carry a stipend of $750.00 per year and can be financed by an association or by individual concerns at a gross cost to them of $1,000 per year. It is hoped that the industries will take further advantage of this type of technical aid.

Hollow Building Tile Association

The Hollow Building Tile Assn. with H. D. Foster as the investigator, is taking advantage of the Station's facilities for the testing of masonry walls under load and have paid for the construction of a standard fire test furnace. Their program is as follows: (1) to gather data upon which fire resistance specifications for partition tile can be based and (2) to improve the quality of hollow building tile by a study of the properties of the individual tile and the tile in walls. A later program will have to do with testing the developments at Roseville and a study of design and its relation to load carrying properties and ability to resist heat shock.

OHIO CERAMIC INDUSTRIES ASSOCIATION FALL MEETING

About 150 manufacturers, in addition to a large number of ceramic and chemical engineering students, attended the two-day fall meeting of the Ohio Ceramic Industries Association held at Columbus, Ohio, November 2 and 3.

A general session was held Friday morning of all divisions and several papers were presented of general interest to all groups. A report was made by Mr. Bole, outlining the work which had been done at the Roseville Experimental Plant.[1]

Papers were presented before the Whiteware Division by F. H. Rhead and H. M. Kraner. A round table discussion was lead by W. K. McAfee and T. B. Anderson on the proposed whiteware experimental station. Mr. McAfee stated that the Ohio whiteware manufacturers would have to get behind the project in an enthusiastic fashion if they wanted to secure a laboratory similar to the heavy clay laboratory at Roseville. The Whiteware Division changed its name to the Porcelain, Stoneware, and Tile Division. T. B. Anderson is Chairman of this Division.

In the Heavy Clay Division, "Modernization" was the key-note of two papers by F. M. Hartford and J. L. Carruthers. A paper presented by F. T. Heath gave data on the structural properties of masonry walls. Mr. Bole talked on the commercial application of the laboratory results in the alteration of the properties of heavy clays by the addition of electrolytes. A demonstration of a fire test of a hollow tile wall at the Engineering Experiment Station was given by H. D. Foster.

F. M. Hartford was elected Chairman and J. L. Carruthers, Secretary of the Heavy Clay Products Division.

In the Refractories Division, an outline of the research program at the Roseville plant dealing with refractories was presented by C. E. Bales who asked for coöperation in supplying test materials and suggestions. M. C. Booze pointed out the advantages to

[1] See article above.

be gained from technical control. The last item on the program was a round table discussion, led by J. R. Cavender, on the proposed state specifications for the purchase of fire brick. A committee was appointed to draw up a specification for the use of state departments.

A separate division meeting was held for the drain tile men for the first time. J. O. Everhart talked on the testing work on drain tile carried on by the Engineering Experiment Station. A. H. Wehringer and J. L. Murphy were in charge of the round table discussion at which this group organized as a division of the Association. C. M. Mumma was elected Chairman and representative on the Board of Trustees. At the request of the Association, the University is putting through a series of radio talks on farm drainage and drain tile manufacture and testing.

The Saturday morning session was of a general nature, at which time reports of committee work were given. Parry Forst gave a report on the work done by the New Jersey clay workers in their kilns survey. The legislative program was discusssed by E. G. Lloyd.

W. K. McAfee, Cambridge Sanitary Mfg. Co., was elected president of the Association.

Other officers elected were C. H. Taylor, Chas. Taylor Sons Company, Vice-President; C. B. Harrop, Harrop Ceramic Service Company, Treasurer; G. A. Bole, Ohio State University, Secretary.

The Board of Trustees for the coming year consists of the following men: W. K. McAfee, C. H. Taylor, C. B. Harrop, J. L. Murphy, T. J. Evans, T. B. Anderson, C. M. Mumma, S. R. Scholes, Earl T. Montgomery, C. Forrest Tefft, John D. Martin, H. C. Downer, F. T. Grant, and J. R. Herrold.

Lunch was served the ceramists in Lord Hall Saturday noon and all those who had been able to secure tickets attended the Ohio State-Princeton Game in the afternoon.

ALUMNI NOTES, OHIO STATE UNIVERSITY, CERAMIC ENGINEERING

Ceramic Engineers, 1928

Robert H. Anwyl is now with the Frigidaire Corporation, Dayton, Ohio.

Chester R. Austin has the Electrical Porcelain Manufacturers Association Fellowship, Graduate School, Ohio State University.

Frederick Bernard has been placed in charge of the firing of kilns at the National Fire Proofing Plant at East Canton, Ohio.

Marion K. Burr is now with the A. P. Green Fire Brick Company, Mexico, Mo.

W. N. Butterworth is with the Harbison-Walker Refractories Co., Mt. Union, Pa.

John Heller, Jr., is with the Jackson Brick & Fire Proofing Co., Ewing, Indiana.

Walter V. Henning is now employed by the Wehrle Stove Company, Newark, Ohio.

Paul Kates is with the Frigidaire Corporation, Dayton, Ohio.

Sidney W. McCann is employed by the Pfaudler Company, manufacturers of enameled cast-iron tanks, at Rochester, N. Y.

Charles McMullen is with the Research Department of the Carborundum Company at Niagara Falls, N. Y.

Edward C. Milliken is with the National Fire Proofing Co., East Palestine, Ohio.

John M. Neff is with the Bausch & Lomb Optical Co., Rochester, N. Y.

John E. Shepherd is employed by the Ohio Neon Lamp Corporation, Cincinnati, Ohio.

George H. Spencer-Strong is with the Mansfield Vitreous Enameling Co., Mansfield, Ohio.

Drury D. Turner is with the Standard Sanitary Mfg. Co., Pittsburgh, Pa.

David C. Zimmer is with the John Douglas Company, Cincinnati, Ohio.

Ceramic Engineers 1915–1927

Roy Beck, Ceramic Engineer, 1925, is now with the Mansfield Vitreous Enameling Company at Mansfield, Ohio.

Raymond E. Birch, Ceramic Engineer, 1927, is with the Engineering Experiment Station Ceramic Research Plant at Roseville, Ohio.

R. E. Hanna, Ceramic Engineer, 1922, is with the U. S. Quarry Tile Company, East Sparta, Ohio.

S. E. Hemsteger, Ceramic Engineer, 1923, now represents the Enterprise White Clay Company of Philadelphia with offices at Middletown, Ohio.

C. H. Hopp, Ceramic Engineer, 1915, who is in business at Bradford, Pa., visited the Ceramic Engineering Department on the day of the Michigan game.

Geo. C. Irvine, Ceramic Engineer, 1927, is with the Carborundum Company at Niagara Falls, N. Y.

Louis Schmunk, Ceramic Engineer, 1923, with the Standard Sanitary Manufacturing Company at Tiffin, Ohio, has been sent to Germany to operate the foreign plant of that company.

C. A. Smith, Ceramic Engineer, 1923, is with the Bigelow-Liptak Corporation of Detroit, Michigan.

CALENDAR OF CONVENTIONS

American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1929	New York City
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	Feb. 4–9, 1929	Chicago, Ill.
(Pittsburgh Section)	Dec. 11	New Castle, Pa.
American Concrete Institute		
(Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Face Brick Assn.	Feb. 4–9, 1929	Chicago, Ill.
American Refractories Institute	Feb. 4–9, 1929	Chicago, Ill.
American Soc. of Mechanical Engrs.		
(Annual Meeting)	Dec. 3–7	New York City
American Soc. for Steel Treating		
(Semi-Annual)	Jan. 14–18, 1929	Los Angeles, Calif.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Los Angeles, Calif.
British Ceramists Tour in America	April 29–May 18, 1929	
Common Brick Mfgrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Hollow Building Tile Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Assn. of Mfrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Exposition of Power & Mechanical Engrs.	Dec. 3–8	New York City
Natl. Glass Distributors Assn.	Dec. 4–5	Pittsburgh, Pa.
Taylor Society	Dec. 5–8	New York City

Ceramic Exposition and Meetings

Chicago, February 4 to 9, Incl.

will

Make Americans Ceramic Conscious

and

Awake Ceramic Industrialists

to

Need of and Benefits from Co-ordination in Ceramic Research and Education

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